

DEEP-SEA FISHES OF THE BERMUDA OCEANOGRAPHIC EXPEDITIONS

FAMILY ALEPOCEPHALIDAE

BY WILLIAM BEEBE

(Figs. 1-25 incl.)

Isospondylous fishes with the border of the upper jaw formed by the premaxillaries and maxillaries; teeth feeble; head naked; scales (when present) thin, deciduous, cycloid; no stout, spinous finrays; dorsal and anal set far back, nearly opposite; no post-dorsal adipose fin; no barbel; light organs present or absent; no serial photophores in double row close to ventral profile; pseudobranchiae present.

Deep-sea fish of temperate and tropical seas, apparently absent from the arctic and antarctic.

Seventeen genera are known, including two here described for the first time.

The Bermuda Oceanographic Expeditions captured 128 specimens of the family, distributed among 8 species and 6 genera.

Of the 13 families of deep-sea Isospondyls represented in the same collection, the Alepocephalids are seventh in order of numerical, third in specific and second in generic abundance.

KEY TO THE GENERA

- A. Snout elongated, tube-like, mouth at tip.
 - a. Anal about equal to or shorter than dorsal. *Dolichopteryx*
 - aa. Anal much longer than dorsal. *Aulostomatomorpha*
- AA. Snout short or moderate.
 - B. Pelvics absent. *Platytroctes*
- BB. Pelvics present.
 - C. Vertical fins very long (D. 48, A. 71) *Leptoderma*
- CC. Vertical fins short or moderate.
 - D. Mandible toothless. *Ericara*
- DD. Mandible with teeth.
 - E. Upper jaw toothless.
 - a. 13 branchiostegal rays. *Leptochilichthys*
 - aa. 5 branchiostegal rays. *Asquamiceps*

- EE. Upper jaw with teeth, at least in premaxillary.
- F. A dermal fold in front of dorsal.
- a. Head large (2 in length) *Anomalopterus*
- aa. Head small (6 in length) *Photostylus*
- FF. No dermal fold in front of dorsal.
- G. Body completely scaled.
- a. Maxillary toothless.
- b. Premaxillary normal, jaws about equal in front. *Alepocephalus*
- bb. Premaxillary expanded, forming a nearly horizontal plate enclosing mandible. *Xenognathus*
- aa. Maxillary with teeth.
- b. Teeth in premaxillary pluriserial. *Narcetes*
- bb. Teeth in premaxillary uniserial.
- c. A large, forwardly-directed, symphysial knob. *Bajacalifornia*
- cc. Symphysial knob minute and ventrally directed, or absent. *Bathytroctes*
- GG. Body naked (or with minute scales in lateral line).
- H. Dorsal twice as long as anal and originating in advance of it. *Macromastax*
- HH. Dorsal and anal equal and opposite.
- a. Dorsal and anal 15 to 21. *Rouleina*
- aa. Dorsal and anal 27 to 30. *Xenodermichthys*

VERTICAL DISTRIBUTION OF THE SPECIES OF ALEPOCEPHALIDAE
TAKEN BY THE BERMUDA OCEANOGRAPHIC EXPEDITIONS

Species	Fathoms										
	0	100	200	300	400	500	600	700	800	900	1000
<i>Anomalopterus megalops</i>	—	—	—	—	—	—	—	×	—	—	—
<i>Bathytroctes drakei</i>	—	—	—	—	×	×	×	×	×	×	—
<i>Bathytroctes rostratus</i>	—	—	—	—	—	×	×	×	×	×	×
<i>Dolichopteryx binocularis</i>	—	—	—	—	×	—	—	—	—	—	—
<i>Dolichopteryx longipes</i>	—	—	—	—	—	—	×	×	×	—	—
<i>Macromastax gymnos</i>	—	—	—	—	—	—	—	—	—	—	×
<i>Photostylus pycnopterus</i>	—	—	—	—	—	—	—	—	×	—	—
<i>Xenodermichthys copei</i>	—	—	—	—	—	—	×	×	—	—	—

Genus **Anomalopterus** Vaillant 1888

Large-headed Alepocephalids with a dermal fold along the dorsal profile in front of the dorsal fin. Elongate; moderately compressed; scales absent; mouth large; teeth present on pre-maxillaries and mandible, sometimes on maxillary or palatine as well; gill opening large; paired fins short, inserted close to ventral profile; dorsal originating slightly in advance of anal and having fewer rays.

Two species, from off Morocco and Bermuda respectively.

Anomalopterus megalops Beebe 1933

(Fig. 1)

TYPE: Department of Tropical Research No. 11,456; Bermuda Oceanographic Expedition of the New York Zoological Society; Net 280; July 10, 1929; 12 miles south of Nonsuch Island, Bermuda; 700 fathoms; Standard length 31 mm.

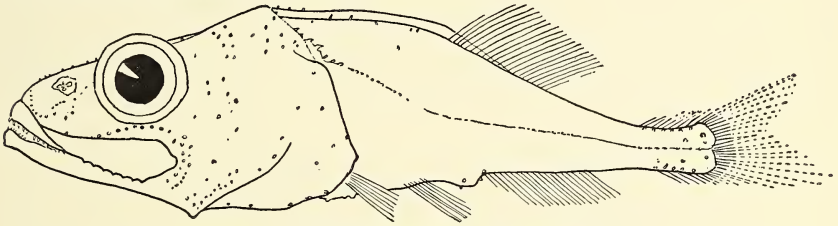


Fig. 1. *Anomalopterus megalops* Beebe. $\times 3$

MEASUREMENTS AND COUNTS: Standard length 31 mm; depth 7.8 (in length 4); head 15.3 (in length 2); maximum thickness 6.5 (in length 4.8); eye diameter, without fold, 3.3 (in head 4.6); eye fold .48; snout 3.8 (in head 4); maxillary 8.2 (in head 1.9); interorbital 2.4 (in head 6.4); brachistegal rays 7, the membranes partially united beneath the isthmus; pectoral rays 7; pectoral length 1.9; pelvic rays 7; pelvic length 2.5; dorsal rays 21; anal rays 20.

EXTERNAL CHARACTERS: The color in the fresh specimen was a dark sepia brown, while the very thin epidermis was transparent, adhering closely and resembling cellophane in its texture.

The contour of this fish is very unusual, being deepest at the

mid-body, sloping gradually forward to a deep, blunt snout, and more rapidly posteriorly, ending in an elongated, slender peduncle. The enormous head is half as long as the entire fish, and the correspondingly large eyes are contained four and a half times in the head. The head slopes evenly to the snout when it descends in an abrupt curve to the mouth. A curve corresponding to that of the nape follows the mandible back to its posterior angle, and from here to the tail the ventral contour is horizontal. The mid-back, throughout the extent of the predorsal fold, is horizontal, the remaining contour, from the anterior insertion of the dorsal fin, descending in a steep, long curve to the caudal fin.

The large eyes are high on the head, interrupting the dorsal profile, and the eye-ball is surrounded by a thick, fleshy fold, making these organs look even larger than they are. The nostrils are conspicuous, slightly nearer the anterior margin of the eye than tip of the snout, and are above a line drawn between these two places. The narial area is very large, measuring a millimetre in diameter, and it is difficult to understand Vaillant's foot-note in the description of *A. pinguis* (1888, p. 161), "Je n'ai pu découvrir les narines." The interorbital breadth is only three-quarters the diameter of the eye.

The mouth is large, with a slight downward slope posteriorly, the maxillary ending just short of the posterior vertical of the eye. The teeth are small, slightly curved and present on the premaxillary, maxillary and the anterior part of the mandible. The maxillary teeth are seven in number and alternate with shallow, rounded scallops. The vomer and palatines are edentulous.

The gill openings are large; the opercula are covered with skin and the posterior margin is smooth. The branchiostegal rays are seven in number and partially united beneath the isthmus.

The lateral line begins at the upper angle of the gill openings, and in the anterior third of the trunk length descends to the mid-line, holding level back to the tail.

The skin is scaleless and smooth except for numerous small tubercles, abundant on the head, and less so on the body, where they are scattered along the dorsal fold and the lateral line, around the anus and at the base of the caudal fin. They are asymmetrically distributed over the two sides of the fish, but show a decided tendency toward a linear arrangement, which argues the presence of a defi-

nite pattern in life. Especially noticeable is the curving line about the tip of the snout and along the maxillary, several short lines in the center of the opercular region, and others along the posterior outline of the mandible. They are very easily rubbed off in the preserved specimen.

The dorsal fold is a low dermal ridge which begins at the nape and extends halfway down the back.

The pectoral fin, inserted but little above the ventral profile, has 7 very short rays, and the pelvic, with an equal number, originates well in advance of the dorsal fin. The latter has 21 rays and occupies about the middle third of the back, encroaching considerably upon the posterior extension of the dermal fold. The anal fin, of 20 elements, occupies the same antero-posterior extent as the dorsal, but extends about half its length behind the dorsal. The caudal is badly injured and the length is uncertain.

DISCUSSION: My specimen No. 11,456 must be referred to the genus *Anomalopterus* on the basis of the two dominant generic characters—the enormous size of the head and the presence of the adipose fold preceding the dorsal fin, unless a new genus be made due to the presence both of maxillary teeth and of dermal tubercles in the present specimen.

The only other species, and in fact individual of the genus, *Anomalopterus pinguis*, was described by Vaillant (1888, p. 160–162; pl. XI, fig. 4, 4a). It was taken on the voyage of the *Talisman* in 1883, near Cape Blanco, Morocco, at a depth of 1400 metres, or 765 fathoms.

Anomalopterus megalops differs from Vaillant's species in the much larger eye, the presence of teeth on the maxillary, the conspicuous nostrils, increased vertical finray counts and the presence of tubercles on the skin.

Even allowance for a difference in age (*pinguis* is twice as long as *megalops*) could not account for the greatly disproportionate size of the eye, the inconspicuousness of the nostrils and the total absence of dermal tubercles.

The following table presents a direct comparison between the two individuals of the two species:

	<i>Anomalopterus pinguis</i> Vaillant	<i>Anomalopterus megalops</i> Beebe
Length	61 mm.	31 mm.
Lgth: depth	3.6	4
Lgth: thickness	7.6?	4.8
Lgth: head	2.	2
Head: eye	20 (fresh, without fold)	4.6 (preserved, without fold)
Head: snout	3	4
Head: interorbital	8.6	6.4
Upper jaw	Nearly $\frac{1}{2}$ head (from fig.)	Like <i>pinguis</i>
Maxillary	Extends beyond parallel from posterior border of orbit.	Ends in front of parallel from posterior border of orbit.
Teeth	Very small on premaxillaries and mandible; larger on palatines; none visible on vomer.	Very small on premaxillaries and mandible; maxillary with 7 small teeth alternating with very shallow scallops; none on palatines or vomer.
Nostril	"Je n'ai pu decouvrir les narines."	Conspicuous, slightly nearer anterior margin of eye than tip of snout, and above horizontal through the center of the eye.
Eye	With cutaneous fold which narrowed it greatly in fresh specimen.	Fold similar to <i>pinguis</i> but eye itself much larger.
Interorbital space	At least double length of eye.	Only three-fourths eye length, but latter is proportionately much greater. Compared with head, interorbital is broader than in <i>pinguis</i> .
Gill opening	Large.	Large.
Operculum	Covered in life by a membranous tegument and largely membranous itself. Only preopercle and opercle distinguishable. A furrowed border with posterior projections.	Similar, but no "furrowed border" nor posterior projections except several of the tubercles, which are generally distributed over the fish.
Skin	Absolutely naked.	Scaleless, but with small tubercles present on head and body.
Lateral line	Begins at upper angle of gill opening; descends rap-	Like <i>pinguis</i> .

	<i>Anomalopterus pinguis</i> Vaillant	<i>Anomalopterus megalops</i> Beebe
	idly to median line, follows latter to caudal.	
Adipose fold	Fold plus dorsal equals 80% of back. Fold occupies anterior 67% of fold plus dorsal. Lower than true dorsal. Extends to dorsal origin.	Fold plus dorsal equals 62% of back. Fold occupies anterior 84% of fold plus dorsal. Similar to <i>pinguis</i> in general character, but neither as high nor as conspicuous. Reaches mid-dorsal.
Dorsal	17	21
Anal	14	20
	Extends slightly beyond dorsal and is not so long.	Extends slightly beyond dorsal and is about same length.
Pectoral	9—very short	7—very short
Pelvic	9	7
	Origin almost opposite rayed dorsal.	Origin well in front of rayed dorsal.
Color	Bluish; iris white.	Dark brown.

Type in the collections of the Department of Tropical Research of the New York Zoological Society.

REFERENCE

Anomalopterus megalops Beebe 1933, p. 159; fig. 39. (Type description).

Genus **Bathytroctes** Günther 1878 (including *Talismania* Goode and Bean 1895)

GENERIC CHARACTERS: Form elongate, moderately compressed; body scaled; head moderately large; maxillary toothed, its posterior border not extending beyond the posterior margin of the orbit (except in *B. stomias*); teeth also present at least in premaxillary and mandible; symphysial knob, if present, small, ventrally directed; branchiostegals 7; paired fins short, inserted fairly close to ventral profile; dorsal fin equal to or longer than anal, originating opposite or in front of it.

NUMBER OF SPECIES: At least nineteen species have been recorded; of these, two were taken by the Bermuda Oceanographic Expeditions.

GEOGRAPHICAL DISTRIBUTION: Members of the genus are known from the Atlantic, Mediterranean, Indian and Pacific Oceans.

VERTICAL DISTRIBUTION: *Bathytroctes* has been caught at depths all the way from 200 to 2700 fathoms; the Bermuda examples came from between 400 and 1000 fathoms, but were most abundant between 600 and 900 fathoms. In the trawling cylinder temperatures of about 52.8° Fah. and 38.7° Fah. were recorded at 400 and 1000 fathoms, respectively.

ABUNDANCE:

World: *Bathytroctes rostratus* is the only species of the genus of which more than five individuals have previously been taken. Of this species, about thirty-five specimens are recorded.

Bermuda: A total of 116 specimens of *Bathytroctes* have been taken by us. In the order of abundance of individuals in the nets, *Bathytroctes* ranks first among the Alepocephalids, eighth among the deep-sea Isospondyls (in a total of 42 genera) and about sixteenth among all the deep-sea fishes (including at least 120 genera).

SOCIABILITY: *Bathytroctes* is probably not gregarious: Practically always but one was found in a single net, rarely two, twice three, once four. On the other hand, in five instances individuals of both *B. drakei* and *B. rostratus* were taken in the same net, making it possible that schools of the young of the two species mingle as in shoals of whitebait—young herring and spratt.

FOOD: Of the twelve stomachs examined, eight contained food. This consisted entirely of small crustaceans and mollusks.

ENEMIES: *Bathytroctes* has not yet been found in the stomach of any animal, nor have parasites been observed.

VIABILITY: None of the Bermuda specimens has been brought alive to the surface.

SIZE: The largest specimen of *Bathytroctes* on record is the type of *B. aequatorius* which measures 362.5 mm. and was taken off the coast of Equador. The smallest is 9 mm. in length, recorded by Murray and Hjort (1912, Pl. IX) from off north-west Africa.

In the present collection the largest specimen of the genus is an immature *B. rostratus* of 56 mm.; the smallest is a larva of the same species measuring 9.5 mm. in length.

DEVELOPMENT: Post-larvae are by far the most numerous in the Bermuda collection; larvae and adolescents are rare; adults are absent. The first three stages were all taken throughout the April-to-September trawling seasons.

BRIEF SUMMARY OF GROWTH STAGE CHARACTERS OF
BATHYTROCTES BASED ON THE BERMUDA MATERIAL

KEY TO GROWTH STAGES:

- A. Yolk sac present; head relatively one-half or less adult size..... LARVA.
- AA. Yolk sac absent; head relatively adult size or longer.
 - B. Paired fins with rays not fully differentiated; no ossification..... POST-LARVA.
 - BB. Paired fins with rays well differentiated; ossification partial..... ADOLESCENT.

Larva: Yolk sac; feeble jaws; teeth almost or entirely lacking; moderate, nearly round eye; small head; pectoral a flap; pelvic absent; dorsal and anal semi-developed or still finfold-like; caudal strong, but heterocercal, no rays; pre-dorsal and pre-anal finfolds present; pigment well developed except on head; no ossification; 9.5 to 14 mm.

Post-larva: No yolk sac; jaws large and strong; teeth developing; eye large, elongate; relatively full size; head of adult proportions; pectoral and pelvic fins developing; dorsal and anal almost fully developed; no finfold; no ossification; 11 to 30 mm.

Adolescent: Pectoral and pelvic fully developed externally, but no ossification of the bases of any of the fins; skull and cleithrum moderately well ossified; gonads partly developed; 28 to 56 mm.

KEY TO THE BERMUDA SPECIES OF *BATHYTROCTES*

- A. No black, supraclavicular process; anterior premaxillary teeth not projecting; snout about equal to diameter of entire eye capsule..... *B. drakei*
- AA. Black, supraclavicular process present; anterior pair of premaxillary teeth projecting, tusk-like; snout shorter than diameter of entire eye capsule..... *B. rostratus*

***Bathytroctes drakei* Beebe 1929**

SPECIMENS TAKEN BY THE BERMUDA OCEANOGRAPHIC
EXPEDITIONS

27 specimens; May to September, 1929 to 1931; 400 to 900 fathoms; from a cylinder of water 8 miles in diameter (5 to 13 miles south of Nonsuch Island, Bermuda), the center of which is at 32° 12' N. Lat., 64° 36' W. Long.; Standard lengths from 10 to 22 mm.

The Species of *Bathytroctes* (including *Talismanica*)

<i>Species</i>	<i>Authority</i>	<i>Locality</i>	<i>No.</i>	<i>Length (mm)</i>	<i>Fathoms</i>	<i>Meters</i>
<i>aequatoris</i>	Goode & Bean 1895	Equador	1	362.5	741	1355
<i>alveatus</i>	Garman 1899	Pacific Panama	2	187.5	1132	2070
<i>alvifrons</i>	Garman 1899	Pacific Panama	2	225	1360, 1793	2487, 3279
<i>antillarum</i>	Goode & Bean 1895	Caribbean	1	—	420	768
<i>attritus</i>	Vaillant 1888	Azores; N. W. Africa	4	250 (type)	789 to 1999	1442 to 3655
	Roule 1919	Near Azores	1	—	947	1732
<i>calcaratus</i>	Weber 1913	Macassar St.	1	265	396	724
		Ceram Sea	1	152	310	567
<i>curvifrons</i>	Roule & Angel 1933	Bay of Biscay	1	105	2461	4500
<i>drakei</i>	Beebe 1929	Hudson Gorge	1	29	800	1463
		Bermuda	27	10 to 22	400 to 900	732 to 1646
<i>grimaldii</i>	Zugmayer 1911	Morocco	1	165	2679	4900
<i>homopterus</i>	Vaillant 1888	Banc d'Arguin	1	161	609	1113
	Norman 1930	West Central Africa	3	47 to 100	328 to 492	600 to 900
<i>inspector</i>	Garman 1899	Pacific Panama	1	250	1471	2690
<i>longifilis</i>	Brauer 1902	Gulf of Aden	1	117	803	1469
<i>macrolepis</i>	Günther 1887	Off Celebes	1	225	2150	3932
<i>melanocephalus</i>	Vaillant 1888	Off West Africa	4	108 (type)	785 to 1422	1435 to 2600
<i>microlepis</i>	Günther 1878	S. E. of C. St. Vincent	1	250	1090	1993
	Alcock 1889	Andaman Sea	1	—	500	914
<i>mollis</i>	Koehler 1896	Bay of Biscay	1	318	930	1700
	Roule 1916, 1919	Azores	1	318	987	1805
<i>rostratus</i>	Günther 1878*		35	9 to 163	200 to 2600	366 to 4755
	N. Y. Zool. Soc. Exp.		89	10 to 56	500 to 1000	914 to 1829
<i>squamosus</i>	Alcock 1890	Bermuda	1		740	1353
	Weber 1913	Arabian Sea	2		557	1018
<i>stomias</i> †	Gilbert 1890	Bali Sea	1	142, 165	877	1604
		Off Oregon	1	325		

* See p. 55 for subsequent records from the Atlantic, Mediterranean & Indian Ocean.

† It seems probable from the description that this specimen is a species of *Narctes* Alcock 1890.

PREVIOUSLY RECORDED SPECIMEN

Type only; 800 fathoms; Hudson Gorge, 125 miles south-east of New York City; Standard length 29 mm.

SPECIFIC CHARACTERS

(From the type specimen; Figs. 2C and 3B).

Bathytroctes drakei may be distinguished immediately from all other members of the genus by the shortness of the mouth. In the present species the posterior end of the maxillary does not quite reach the vertical from the anterior rim of the eye-ball, while in the

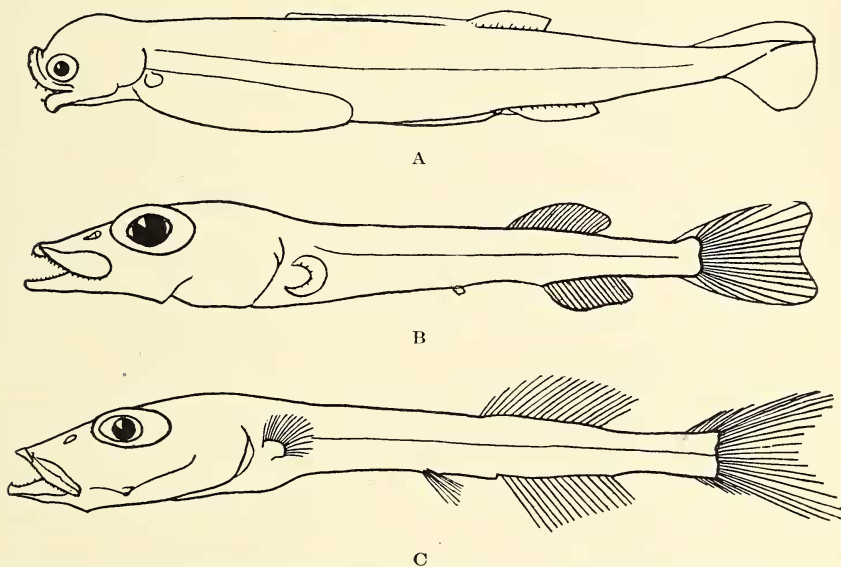


Fig. 2. *Bathytroctes drakei* Beebe. A, larva, 11.5 mm.; B, post-larva, 15 mm.; C, adolescent (type specimen), 29 mm.

rest of the species it extends at least to that from the middle of the eye. From *B. rostratus*, the other Bermuda species, it differs also in the more slender body (depth 10 in length, not 4.3 to 5), longer snout (3.2 in head instead of about 3.8), in the absence of protruding premaxillary teeth and in the lack of a supraclavicular process. *Color*: Light gray (brownish in preservative), with the head darker, and the opercles and abdomen nearly black. *Proportions*: Depth in length 10; head in length 2.8; eye in head 3; snout in head 3.2;

maxillary in head 3.4. *Fin Ray Counts*: Pectoral 16; pelvic 7; dorsal 18, originating in front of the anal; anal 15. *Teeth*: Present in premaxillaries (10 pairs), maxillaries (22 pairs), mandible (10 pairs), vomer (3 or 4 pairs) and palatines (about 3 pairs). All are minute, the premaxillaries and maxillaries about equal in size, those of the mandible even smaller, with wide spaces between.

DEVELOPMENT

The 28 known specimens of *Bathytroctes drakei*, including the Hudson Gorge type, group themselves into the larval, post-larval and adolescent growth stages. The great majority of the specimens are post-larvae, there being but three larvae and one adolescent (the type). The relation of these growth stages to their standard length and numerical abundance in the Bermuda collection may be seen from the following table.

THE RELATION OF GROWTH STAGE TO LENGTH AND NUMERICAL ABUNDANCE IN *Bathytroctes drakei*

Length in mm	Larvae	Transitional Larvae	Post-larvae	Transitional Post-larvae	Adolescents	Transitional Adolescents	Adults	Total
10-11	1							1
12-13	1	1	2					4
14-15	1		10					11
16-17			7	1				8
18-19			1					1
20-21				1				1
22-23				1				1
	—	—	—	—	—	—	—	—
	3	1	20	3				27

LARVA: (Fig. 2A). The three larvae, characterized briefly by the presence of a yolk sac and the lack of pelvic fins, measure 10, 11.5 and 14 mm respectively. The 11.5 mm specimen is described below:

Trawling Data: Department of Tropical Research No. 21,936; Bermuda Oceanographic Expeditions of the New York Zoological Society; Net 1137; Aug. 6, 1931; 9 miles south of Nonsuch Island, Bermuda; 600 fathoms; Standard length 11.5 mm.

Measurements and Counts: Standard length 11.5 mm; depth 1.5 (in length 7.6); head 1.7 (in length 6.8); eye, horizontal, .48 (in head 3.1); eye, vertical, .38 (in head 3.9); snout .27 (in head 5.5); dorsal rays 13; anal rays 10.

External Characters: Body light brown; head, opercles and bases of fin rays white.

The sub-cylindrical, elongate body (excluding the yolk sac) is deepest between the yolk sac and the anal origin; posterior to this it tapers above and below to the slender, very slightly upturned urostyle. The yolk sac projects but little beyond the line of the ventral profile, and extends over about three-fifths of the distance between the opercles and the anus.

The head is small, the rounded crown being slightly higher than the nape. The brain (Fig. 3A) is enormous, nearly filling the top of the head from nostrils almost to the plane of the opercular margins. Relatively, it is twice as large as in the adolescent or over one-third the actual size of the latter, although the larval head length is only a sixth that of the adolescent. The short snout is abruptly upturned, and extends beyond the feeble lower jaw. The angle of the latter is barely discernible at a point about two-thirds of the way from the mandible tip to the posterior border of the opercle. The eye is almost round, and the iris of a nearly constant width. The gape extends to the posterior part of the eye, the up-curved upper jaw having a fleshy lip and indeterminate boundaries. A few feeble, minute teeth are scattered along the maxillary and mandible. The opercular flap is well developed.

There is no trace of scales.

A shallow finfold extends over the posterior half of the distance between the snout and the dorsal origin, and a similar one on the ventral profile lies between the posterior end of the yolk sac and the anal origin.

The pectoral fins consist of minute, white, rayless pads lying on the upper anterior surface of the yolk sac. There is no trace of pelvics. The dorsal and anal are clearly marked off and in the same relative positions as in the type specimen, with the dorsal originating definitely in advance. They are, however, very low and have fewer rays (about 13 and 10 instead of 18 and 15 respectively), and these are not all distinct, though the bases of the rays are fairly well differentiated. The caudal, although still in the finfold stage,

unforked and with no trace of individual rays, is yet functionally well developed; it completely surrounds the urostyle, but extends very little beyond it, and four-fifths of its vertical development is below it.

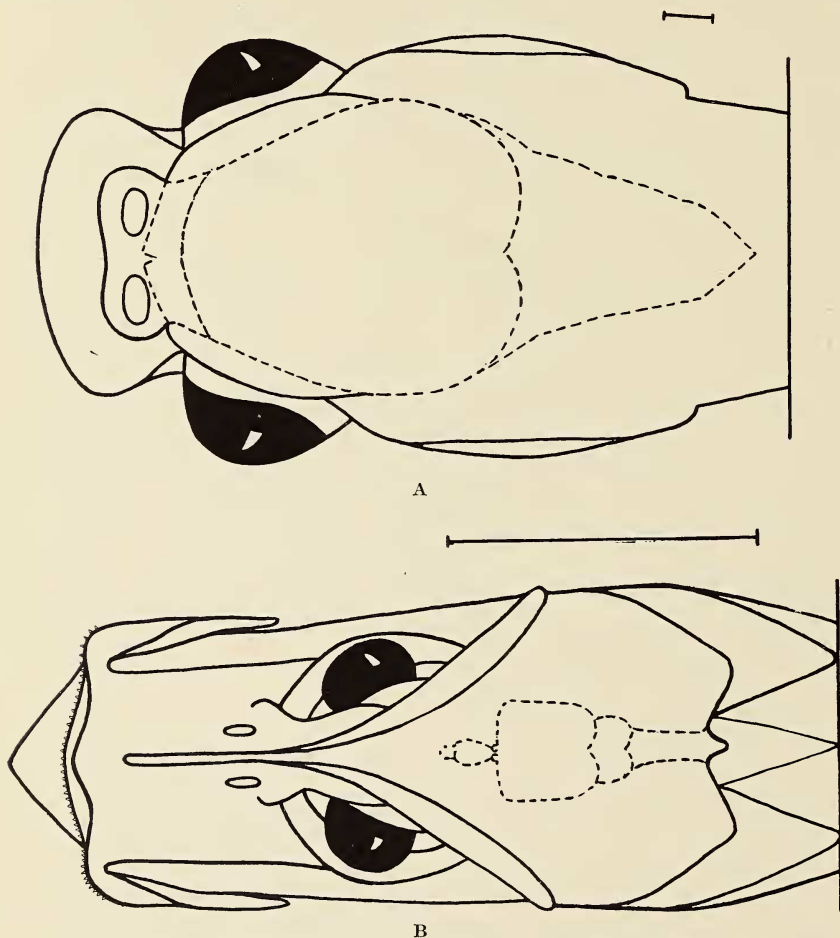


Fig. 3. *Bathytroctes drakei* Beebe. Dorsal views of head, showing position of brain in A, larva; and B, adolescent (type specimen). The relative size of the heads is indicated by the straight lines.

Comparison with Other Larvae: No. 13,470, standard length 14 mm, is at a less advanced stage than the 11.5 mm specimen just described, with a larger yolk sac and deeper finfolds. A shrinkage

in length before the transformation to the post-larval stage is thus indicated. The 10 mm specimen (No. 16,067) is very similar to that of 11.5 mm.

POST-LARVA: (Fig. 2B). The post-larval stage is briefly characterized externally by the partial development of the paired fins: The pectorals are composed of raylets instead of true rays and the pelvics are just appearing. The following specimen is a typical example:

Trawling Data: Department of Tropical Research No. 15,358; Bermuda Oceanographic Expeditions of the New York Zoological Society; Net 628; May 23, 1930; 8 miles east of Nonsuch Island, Bermuda; 600 fathoms; Standard length 16.5 mm.

Measurements and Counts: Total length 19.2 mm; standard length 16.5 mm; depth 2 (in length 8.2); head 6.3 (in length 2.6); eye, horizontal, 2.1 (in head 3); eye, vertical, 1.1 (in head 5.7); snout 2 (in head 3.1); dorsal rays 18; anal rays 14.

External Characters: In color this specimen closely resembles the type, being, when fresh, brownish gray with opercles and abdomen almost black.

The moderately compressed and elongate body tapers gradually from the shoulders to the base of the caudal. There is no trace of upturned urostyle, yolk sac or finfolds.

The head is relatively more than twice as large as in the larva, the crown considerably higher than the shoulder and sloping gradually from here to the tip of the rather long snout. The firm line of the mandible extends straight backward to its sharp angle at the vertical from the posterior part of the iris. The dorsal portion of the very elongate eye interrupts the profile of the head; the lens is set in the middle of an elliptical socket, which is so placed that the posterior part of the iris is broader than the anterior. The nostril is placed high on the snout, slightly nearer the anterior margin of the eye than the tip of the premaxillary. The well defined maxillary extends to just beyond the anterior border of the iris. Minute teeth are present in a single series on the premaxillary, maxillary and mandible in about the same numbers as in the type. There are three pairs on the vomer, and three teeth on each palatine.

There is no trace of scales.

The pectoral fin bases are fleshy pads like those of the larva, but these are now broadly fringed with raylets, though neither true

rays nor their bases are as yet distinct. The pelvics are a pair of minute, whitish projections well in front of the vertical from the dorsal origin. The dorsal, anal and caudal are relatively almost as well developed as in the adolescent type specimen, with all of the rays perfectly distinct.

Osteology: Three post-larvae, measuring 12.6 mm, 15 mm, and 15 mm respectively, have been cleared and stained, and in none is there the least trace of ossification.

ADOLESCENT: As has been said, the type specimen already described is the only example of the adolescent stage. Externally it differs most noticeably from the post-larva in the full development of the paired fins; otherwise the two stages are very similar in general contour and proportions.

SUMMARY OF DEVELOPMENT: The changes which take place during the growth of *Bathytroctes drakei* are summarized in the following tables. These results are drawn from a comparative study of all of the specimens in the collection.

*Practical Summary of Changes Taking Place
During Growth*

Larva: 10 to 14 mm. Yolk sac well developed; jaws feeble with a few minute teeth; snout and head each very short; eyes large, but round, not horizontally elongate; caudal alone of the fins functionally well developed; pectoral a fleshy pad; pelvics invisible; moderately deep finfolds present in front of dorsal and anal; pigment well developed on trunk, absent on head and fins.

Transition: 12 mm. Yolk sac gone; jaws taking form; teeth more numerous and stronger; snout lengthening out with the jaws; head of adolescent size proportionately; no finfolds; beginning of pectoral raylets; pigment more general than in larva.

Post-larva: 13 to 19 mm. Adolescent proportions of head established: Snout and entire eye capsule each about $\frac{1}{3}$ of head; dorsal, anal and caudal with well developed rays and proportions; pectoral and pelvic without true, countable rays, the pelvic being barely visible; pigment generally distributed, heaviest on opercles and abdomen; no ossification.

Transition: 17 to 22 mm. Paired fins with rays partially differentiated and of almost adolescent length.

Adolescent: 29 mm. Paired fins with rays entirely differentiated.

Adult: Unknown.

ORDER OF DEVELOPMENT OF PRINCIPAL EXTERNAL CHARACTERS

KEY:
..... Development started.
----- Half developed.
_____ Fully developed (i. e. in regard to appearance and proportions, but not actual size, as compared with the type specimen).

	LARVA	POST-LARVA	ADOLESCENT
Number of Specimens	4	23	1
Locality	Bermuda	Bermuda	Hudson Gorge
Season	June to Sept.	May to Sept.	July
Vertical Distribution	600 to 900 F.	400 to 900 F.	800 F.
Length	10 to 14 mm	11.5 to 22 mm	29 mm
External Characters:			
Yolk sac	_____		
Profile finfolds	_____		
Heterocercal caudal fold	_____		
Homocercal caudal fin		_____	
Dorsal and anal fins	-----	-----	-----
Pigment	-----	-----	-----
Eye	-----	-----	-----
Snout and jaws	.....	.....	.....
Teeth	.....	.....	.....
Head length	.....	.....	.....
Pectoral fin	.....	.....	.....
Pelvic fin		.....	.....

ECOLOGY

VERTICAL AND SEASONAL DISTRIBUTION: The accompanying table (Fig. 4) shows the vertical, monthly and yearly distribution of the specimens of *Bathytroctes drakei* taken off Bermuda. From the graphs (Figs. 5 and 6) it will be seen that this species was taken only between 400 and 1000 fathoms, with the majority of the specimens occurring between 600 and 900 fathoms, while the months of greatest abundance were May and September.

The table below correlates the data of the graphs just mentioned with length and growth stage (discussed under DEVELOPMENT), and gives in addition average depths and lengths:

Fathoms	April			May			June			July			Aug.			Sept.			Total		
	1929	1930	1931	1929	1930	1931	1929	1930	1931	1929	1930	1931	1929	1930	1931	1929	1930	1931	1929	1930	1931
400	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
500	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—	1	—	—	2	1	—
	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—	1	—	—	3	—	—
600	—	—	—	2	—	—	—	—	—	—	—	—	1	1	—	2	1	1	2	4	2
	—	—	—	2	—	—	—	—	—	—	—	—	2	—	—	4	—	—	8	—	—
700	—	—	—	1	—	—	—	—	—	1	—	—	1	—	—	1	—	—	2	2	—
	—	—	—	1	—	—	—	—	—	1	—	—	1	—	—	1	—	—	4	—	—
800	—	—	—	1	—	—	—	—	—	1	—	—	—	—	—	3	—	—	4	1	—
	—	—	—	1	—	—	—	—	—	1	—	—	—	—	—	3	—	—	5	—	—
900	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	3	1	—	4	2	—
	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—	4	—	—	6	—	—
1000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	1	5	—	2	—	—	1	1	1	1	1	1	9	3	1	12	12	3
	—	—	—	6	—	—	2	—	—	3	—	—	3	—	—	13	—	—	27	—	—

Fig. 4. *Bathytroctes drakei* Beebe. The vertical, monthly and yearly distribution of the specimens taken by the Bermuda Oceanographic Expeditions.

RELATION OF MONTH, NUMBER OF SPECIMENS, DEPTH, LENGTH
AND GROWTH STAGE

Month	Number	Depth in Fath:		Length in mm:		Growth Stages
		Extremes	Average	Extremes	Average	
April	—	—	—	—	—	—
May	6	400-900;	667	13 to 19;	15.3	Post-larval
June	2	500-900;	700	10 to 16;	14	Larval, Post-larval
July	3	500-800;	667	12 to 20;	15.3	Post-larval
Aug.	3	600-700;	633	12 to 14;	13.3	Larval, Post-larval
Sept.	13	500-900;	738	12 to 22;	15.5	Larval, Post-larval
Total	27	400-900;	700	10 to 22;	15.2	Larval, Post-larval

From this it is seen that the average depths and lengths hold remarkably constant throughout the trawling season, showing no evident relationship. However, the number of specimens captured is too small to justify more than the most general conclusions on these subjects.

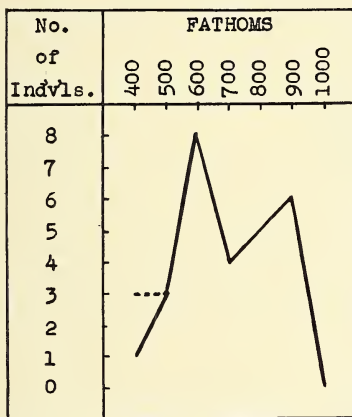


Fig. 5. (Left). *Bathytroctes drakei* Beebe. The vertical distribution of the specimens taken by the Bermuda Oceanographic Expeditions. The broken line is based on the number of specimens which would theoretically have been taken at 400 fathoms if as many nets had been drawn at that depth as at the others.¹

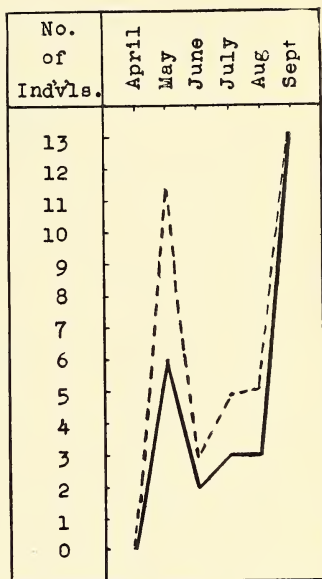


Fig. 6. (Right). *Bathytroctes drakei* Beebe. The seasonal distribution of the specimens taken by the Bermuda Oceanographic Expeditions. The solid line is based upon the actual number of specimens taken; the broken line upon the number which would theoretically have been caught if as many nets had been drawn every month as during September.²

SOCIABILITY: *Bathytroctes drakei* was always taken singly, with one exception, when two 16 mm post-larvae were found in the same net.

ABUNDANCE: Though second in order of numerical abundance among the Bermuda Alepocephalidae, *B. drakei* is less than one-third as common as *B. rostratus*, and, compared with other deep-sea fish, moderately rare. It is represented in 2.8 per cent of all of the nets drawn between 400 and 900 fathoms, the limits of its vertical distribution.

¹ See Introduction, p. 8.

² See Introduction, p. 7.

FOOD: The stomachs of six post-larvae, measuring from 15 to 22 mm, were opened with the following results:

15 mm	1 Copepod (length 1 mm without antenna)
16 mm	Empty
16 mm	Empty
17 mm	1 small Pteropod
19 mm	Finely digested, unrecognizable material
22 mm	Finely digested crustacean remains

STUDY MATERIAL

The following list gives the catalogue number, depth in fathoms, date, length and growth stage of each specimen of *Bathytroctes drakei* taken by the Bermuda Oceanographic Expeditions. All were caught in the cylinder of water off the Bermuda coast described on p. 5. "Lar. Trans." indicates the Transition Stage between Larva and Post-larva. "P.-lar. Trans." indicates the Transition Stage between Post-larva and Adolescent.

No. 10,105;	Net 117;	900 F.;	May 18, 1929;	12.5 mm;	Post-larva.
No. 11,540;	Net 294;	800 F.;	July 12, 1929;	14 mm;	Post-larva.
No. 12,423;	Net 380;	700 F.;	Aug. 16, 1929;	14 mm;	Post-larva.
No. 12,890a;	Net 407;	900 F.;	Sept. 2, 1929;	16, 16 mm;	Post-larvae.
No. 12,981;	Net 413;	900 F.;	Sept. 3, 1929;	15 mm;	Post-larva.
No. 13,047;	Net 417;	600 F.;	Sept. 4, 1929;	15 mm;	Post-larva.
No. 13,332;	Net 447;	800 F.;	Sept. 9, 1929;	14 mm;	Post-larva.
No. 13,470;	Net 466;	700 F.;	Sept. 12, 1929;	14 mm;	Larva.
No. 13,762;	Net 499;	800 F.;	Sept. 24, 1929;	16 mm;	Post-larva.
No. 13,803;	Net 505;	600 F.;	Sept. 25, 1929;	16 mm;	Post-larva.
No. 13,843;	Net 514;	800 F.;	Sept. 27, 1929;	22 mm;	P.-lar. Trans.
No. 14,965;	Net 573;	400 F.;	May 14, 1930;	19 mm;	Post-larva.
No. 14,948;	Net 577;	800 F.;	May 14, 1930;	16 mm;	Post-larva.
No. 15,349;	Net 627;	600 F.;	May 23, 1930;	14 mm;	Post-larva.
No. 15,358;	Net 628;	600 F.;	May 23, 1930;	17 mm;	P.-lar. Trans.
No. 15,518a;	Net 647;	700 F.;	May 29, 1930;	13 mm;	Post-larva.
No. 16,033;	Net 707;	500 F.;	June 16, 1930;	16 mm;	Post-larva.
No. 16,067;	Net 716;	900 F.;	June 17, 1930;	10 mm;	Larva.
No. 17,057;	Net 799;	700 F.;	July 15, 1930;	20 mm;	P.-lar. Trans.
No. 17,424;	Net 811;	600 F.;	Aug. 28, 1930;	14 mm;	Post-larva.
No. 17,779;	Net 838;	600 F.;	Sept. 3, 1930;	12 mm;	Post-larva.
No. 17,841;	Net 845;	900 F.;	Sept. 4, 1930;	15 mm;	Post-larva.
No. 18,835;	Net 916;	500 F.;	Sept. 19, 1930;	15.5 mm;	Post-larva.
No. 21,620;	Net 1108;	500 F.;	July 27, 1931;	11.5 mm;	Lar. Trans.
No. 21,936;	Net 1137;	600 F.;	Aug. 6, 1931;	11.5 mm;	Larva.
No. 23,055;	Net 1255;	600 F.;	Sept. 3, 1931;	14.5 mm;	Post-larva.

Nos. 10,105 (KOH No. 1143), 13,047 (KOH No. 864) and 17,841 (KOH No. 1144) have been cleared and stained in order to study the skeleton.

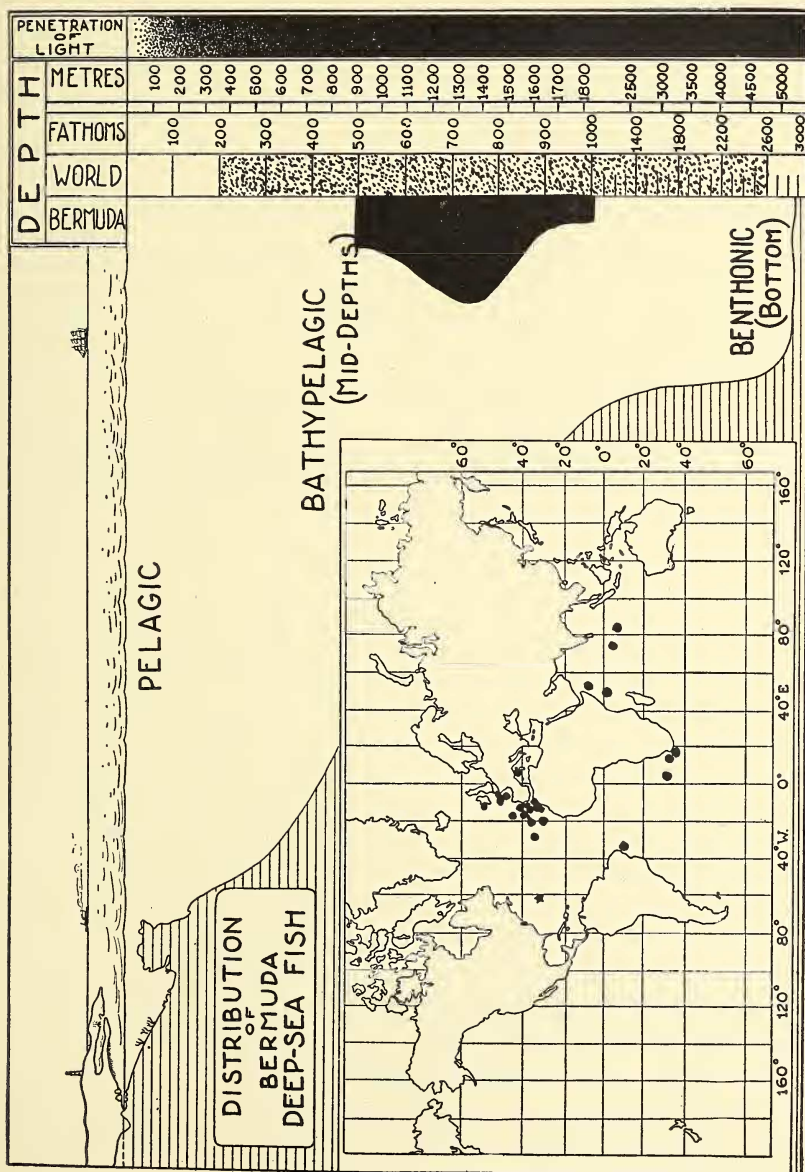


Fig. 7. *Bathutrodes rostratus* Günther. The approximate geographical and vertical distribution of all recorded specimens. The relative number of specimens taken at different depths by the Bermuda Oceanographic Expeditions is shown diagrammatically at the right, for comparison with the previously known vertical range of the species.

The following drawings are filed: B508, B868, B869, B893.

REFERENCE

Bathytroctes drakei

Beebe 1929, p. 6. (Type description).

Bathytroctes rostratus Günther 1878

SPECIMENS TAKEN BY THE BERMUDA OCEANOGRAPHIC EXPEDITIONS

89 specimens; April to September, 1929 to 1931; 500 to 1000 fathoms; from a cylinder of water 8 miles in diameter (5 to 13 miles south of Nonsuch Island, Bermuda), the center of which is at 32° 12' N. Lat., 64° 36' W. Long.; Standard lengths from 9.5 mm to 56 mm. First record of occurrence in western Atlantic.

PREVIOUSLY RECORDED SPECIMENS

About 35 specimens; 200 to 2600 fathoms; North and South Atlantic Oceans, Mediterranean Sea and Indian Ocean; Standard lengths from 9 mm to 162.5 mm. (See Fig. 7).

ADULT SPECIFIC CHARACTERS

(Figs. 8E and 9d)

Bathytroctes rostratus is easily distinguished from other members of the genus by the character of the first premaxillary tooth, which is enlarged and directed almost straight forward, and by the presence of a fleshy, black, supraclavicular process immediately behind the opercle. *Color*: Grayish-brown to violet-black, head sometimes lighter; eye bluish. *Proportions*: Depth in length 4.3 to 5; head in length 3 to 4.4; eye in head 3 to 3.7; snout in head 3.7 to 3.8. *Fin Ray Counts*: Pectoral 16 or 17; pelvic 9; dorsal 17 to 20, originating in advance of anal; anal 16 or 17. *Teeth*: uniserial teeth present on premaxillary, maxillary, mandible, vomer, and, sometimes, palatine; all minute, except for premaxillary fangs; mandibular teeth smallest, and those near the symphysis are external to the lateral ones, which are set in the upper edge of the bone.

DEVELOPMENT

The Bermuda collection of *Bathytroctes rostratus* consists of larvae, post-larvae and adolescents only, not a single adult having

been taken. The post-larvae are by far the most numerous. The relation of these growth stages to standard length and numerical abundance is shown in the following table.

THE RELATION OF GROWTH STAGE TO LENGTH AND
NUMERICAL ABUNDANCE IN *Bathytroctes rostratus*

Length in mm	Larvae	Transitional Larvae	Post-larvae.	Transitional Post-larvae	Adolescents	Transitional Adolescents	Adults	Total
10-11	2	4	2					8
12-13	1	4	15					20
14-15		1	24					25
16-17			16					16
18-19			4					4
20-21			4					4
22-23			1	1				2
24-25				2				2
26-27				1				1
28-29				1	1			2
30-31				1				1
32-33					1			1
34-35								
36-37					1			1
38-39					1			1
40-41								
42-43								
44-45								
46-47								
48-49								
50-51								
52-53								
54-55								
56-57					1			1
	3	9	66	6	5			89

EGG: About 200 minute, partially developed, round, white eggs .05 mm in diameter were counted in each ovary of the largest specimen in the present collection (No. 13,081, standard length 56 mm).

LARVA: (Figs. 8A and 9a). Twelve examples of the larval

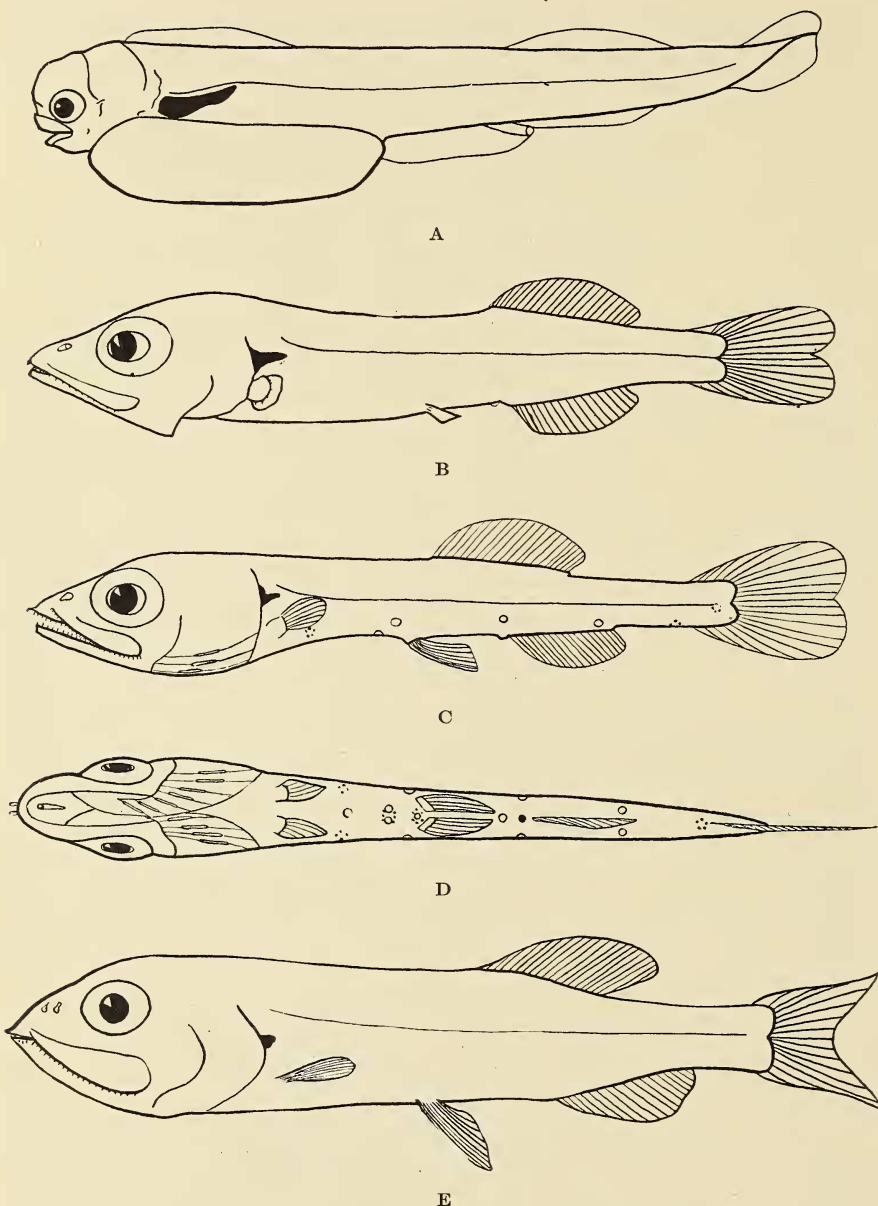


Fig. 8. *Bathytroctes rostratus* Günther. A, larva, 9.5 mm.; B, post-larva, ca. 15 mm.; C and D, adolescent, ca. 56 mm., showing photophores; E, adult, ca. 163 mm. (A, B, C and D after specimens taken by the Bermuda Oceanographic Expeditions; E, after Günther).

stage, characterized by the persistence of a yolk sac, were taken in Bermuda and measure from 9.5 mm to 14 mm. These agree well with the specimens figured by Murray and Hjort (1912, Pl. IX), except that in the Bermuda specimens there is no sign of a finfold along the middle of the back immediately in front of the future position of the dorsal fin. The youngest of the Bermuda specimens is described below.

Trawling Data: Department of Tropical Research No. 16,301; Bermuda Oceanographic Expeditions of the New York Zoological Society; Net 738; June 28, 1930; 6 miles south of Nonsuch Island, Bermuda; 800 fathoms; Standard length 9.5 mm.

Measurements and Counts: Standard length 9.5 mm; depth 1.1 (in length 8.6); head, measured to base of supraclavicular process, 1.6 (in length 5.9); eye, horizontal, .5 (in head 3.2); eye, vertical, .4 (in head 4); snout .2 (in head 8); supraclavicular process .9 (in head 1.8); length of yolk sac 3.5.

External Characters: In color the larva is light brown, except for the pale head and the dark brown, transparent-tipped, supraclavicular process.

The sub-cylindrical, elongate body is deepest (excluding the yolk sac) just anterior to the middle of the total length. Posterior to this it tapers gradually above and below to the very slender, abruptly upturned urostyle. A yolk sac of moderate size interrupts the ventral profile at the vertical from the end of the eye and extends two-thirds of the distance between this point and the anus.

The crown of the small, rounded head is scarcely higher than the level of the shoulders, and the very short, blunt snout and the mouth are directed obliquely downward, though to a lesser degree than in the slightly younger specimen figured by Murray and Hjort. The eye is obliquely set and slightly elongate, with the posterior portion of the iris much broader than the anterior. The mouth is small with a fleshy, protruding upper lip, the gape extending only to about the middle of the eye; no mandibular or maxillary angles are visible. There are no teeth. The opercula are undeveloped, leaving exposed the rudimentary gills.

There is no trace of scales. The supraclavicular process is relatively larger than at any other stage (see Fig. 9a), the anterior half attached to the skin beneath it.

On the dorsal profile a fairly deep finfold extends over the

anterior two-fifths of the distance between the nape and the vertical from the anus. Ventrally, between the end of the yolk sac and the anus, is another, the deepest on the body.

The pectoral fins are represented by minute, white, rayless pads, but the pelvics are absolutely invisible. The vertical fins are still in the form of finfolds, placed nearly opposite each other in the posterior half of the body, relatively longer than the future fins, slightly shallower than the anterior dorsal finfold, and with no sign of either fin bases or rays. The caudal, also, is in the form of a rayless finfold; it is damaged in this specimen, but in the other larvae it completely surrounds the urostyle, though extending but slightly beyond it, and is deepest ventrally.

There is no trace whatever of light organs.

Digestive System: The feeble character of the mouth and the perseverance of a well developed yolk sac in this specimen makes it probable that the larva is still drawing most of its nourishment from the yolk. The tip of the gut is visible through the posterior part of the pre-anal finfold, but does not protrude beyond it.

POST-LARVA: (Figs. 8B and 9b). The great majority of all the Bermuda specimens taken were in the post-larval stage of development, briefly characterized externally by partially developed teeth and paired fins. In all, seventy-two specimens were taken, measuring from 11 to 30 mm. Below are given descriptions of typical examples.

Trawling Data: For all characters except the skeletal system the following specimen was examined: Department of Tropical Research No. 12,890; Bermuda Oceanographic Expeditions of the New York Zoological Society; Net 407; Sept. 2, 1929; 10 miles south of Nonsuch Island, Bermuda; 900 fathoms; Standard length 15 mm.

For osteology; Department of Tropical Research Nos. 14,730 and 19,116; Cleared and Stained Collection Nos. 865 and 1146; Standard lengths 15 mm and 12.8 mm respectively.

Measurements and Counts: Total length 17.4 mm; standard length 15 mm; depth 2.4 (in length 6.3); head 4.6 (in length 3.3); eye, horizontal, 1.6 (in head 2.9); eye, vertical, 1.2 (in head 3.8); snout 1.4 (in head 3.3); dorsal rays 19; anal rays 16; supraclavicular process .7 (in head 6.6).

External Characters: The fish as a whole is dusky brown, darker than the larva, the top of the head transparent, the opercles and

abdomen blackish-brown, and the supraclavicular process black throughout its length.

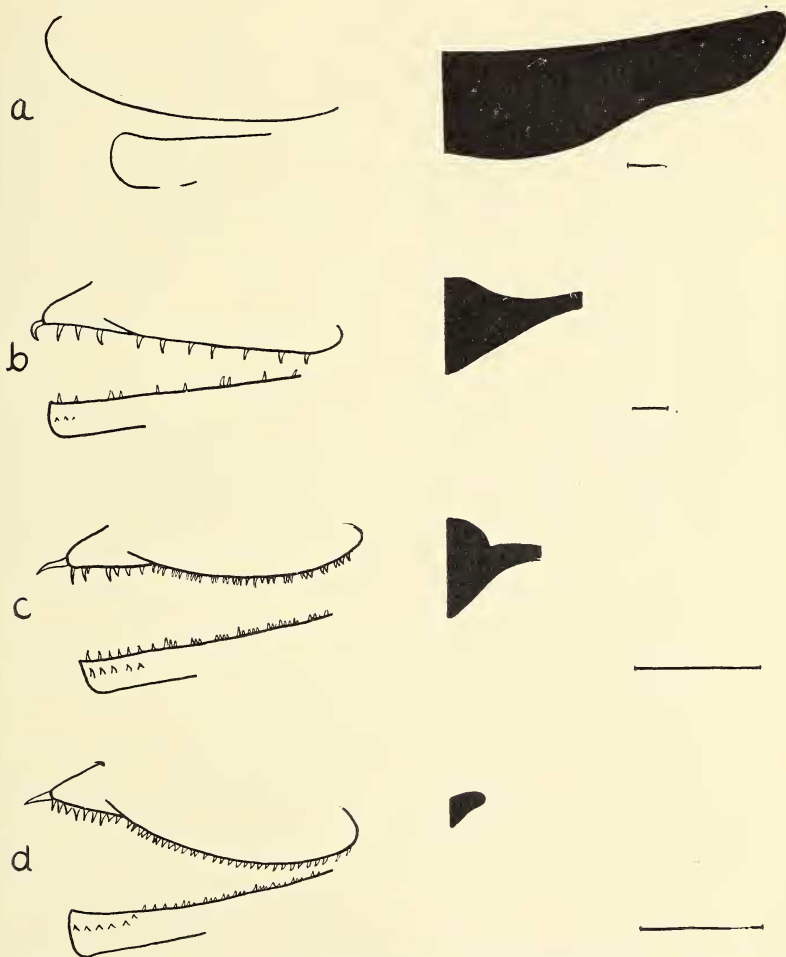


Fig. 9. *Bathytroctes rostratus* Günther. Diagram showing development of teeth and decrease in relative size of supraclavicular process with growth. The relative actual lengths of the processes are indicated by the straight lines. a, larva, 9.5 mm ; b, post-larva, 15 mm. ; c, adolescent, 36 mm. ; d, adult, ca. 163 mm. (a, b and c from specimens taken by the Bermuda Oceanographic Expeditions ; d, after Günther's description and figure).

The body is moderately compressed and elongate, deepest at the nape, and tapering regularly from here to the caudal base. There is no trace of up-turned urostyle, yolk sac or finfolds.

The head and snout are long, relatively more than twice as large as in the larva, and slightly longer than in the adult. The crown is somewhat higher than the nape. The forehead and snout slope gently to the tip of the jaws, which are well formed, the upper protruding slightly beyond the lower. Ventrally the mandible extends downward and back in a straight line to the prominent angle of the jaw, which is behind the vertical from the posterior margin of the eye. The eyes are elongate, set obliquely in the head, the posterior portion of the iris broader than the anterior and the round lens set in the forward part of an elliptical socket. The nostrils are placed high on the snout, about midway between its tip and the anterior margin of the eye. The maxillary extends to a point halfway between the verticals from the end of the lens and the posterior margin of the iris.

The teeth (Fig. 9b) are arranged as follows in each half of the upper and lower jaws: Premaxillary 4, the most anterior slightly enlarged, curved, directed obliquely forward. Maxillary 7, widely set. Mandibular ridge about 10, smaller than those in the maxillary, more closely set, but all in a single row. On each side of the mandibular symphysis, below and outside of the series just described, are three minute, feeble teeth. On the vomer is a single pair of well developed teeth.

There is no trace of scales, though this may be due to the fact that much of the skin is missing. The supraclavicular process is free from the underlying tissues except at its base.

The pectoral fins consist of thick, white fleshy pads with a fringe of finfold-like raylets, individually indistinct. The pelvics are comparatively better developed: in a good light the bases of the individual rays are distinctly visible. Relatively they are about half as long as they are shown in the figure of the adult type specimen. The dorsal and anal are well developed, with almost as many rays as in the adult and with the ray bases, at least, individually distinct. The caudal is strongly developed, homocercal, slightly forked.

The photophore found beneath the symphysis of the lower jaw in older specimens is the only one even partially developed in the present case. It is represented by a small, round, subcuticular white spot covered with a narrow band of whitish, transparent skin which extends backwards to the junction of the mandibular ligaments.

Osteology: There is absolutely no trace of ossification in any part of either of the cleared specimens, which measure 12.8 mm and 15 mm.

Digestive System: The arrangement of the digestive organs is essentially the same as in the adolescent fish described below (Fig. 11). The following differences are, however, marked: The intestine leaves the stomach directed straight forwards and proceeds some distance before turning back upon itself, instead of curving backward at its origin; there are no coils in the region of the pelvic fin; there are no pyloric caeca; finally, the liver is proportionately smaller. The black pigment of the stomach is quite as well developed as in the older fish.

Reproductive System: The gonads are visible as two slender, whitish tubes lying the length of the coelom against its dorsal wall.

ADOLESCENT: (Figs. 8C, 8D and 9c). This stage is represented in the Bermuda collection by five specimens measuring from 28 mm to 56 mm. Intermediate between post-larva and adult, its distinguishing external characteristics are the presence of two equally developed rows of teeth in the anterior part of the mandible and a number of conspicuous light organs.

Trawling Data: All of the characters described below except those of the skeletal system are taken from the following specimen: Department of Tropical Research No. 13,081; Bermuda Oceanographic Expedition of the New York Zoological Society; Net 421; September 4, 1929; 10 miles south of Nonsuch Island, Bermuda; 1000 fathoms; Standard length 56 mm. This is the largest specimen in the collection, a female.

The observations on the skeletal system were made from Department of Tropical Research Nos. 13,467a and 16,937 (Cleared and Stained Collection Nos. 1145 and 863), measuring 32 mm and 38 mm respectively.

Measurements and Counts: Total length 64 mm; standard length 56 mm; depth 8.6 (in length 6.5); head 21 (in length 2.7); eye, horizontal, 5.6 (in head 3.7); eye, vertical, 4.6 (in head 4.6); snout 5.6 (in head 3.7); maxillary 12.4 (in head 1.7); pectoral rays 17; pelvic rays 9; dorsal rays 20; anal rays 17; supraclavicular process 2.9 (in head 7.2), measured along its dorsal margin, from edge of opercle to its most posterior tip; gill rakers in lower half of first branchial arch 13.

External Characters: In color this adolescent specimen is similar to the post-larva, except that both the brown body and the blackish brown opercles and abdomen are slightly darker. In general contour and proportions the two growth stages resemble each other closely, although in the adolescent the head is relatively a very little shorter and the eye smaller. The maxillary extends to a point immediately beyond the vertical from the posterior margin of the orbit.

The teeth (Fig. 9c) are arranged as follows: In the premaxillary the two teeth at the symphysis are well separated from each other, large, spine-like and directed straight forward, the extreme tips being slightly curved and (probably abnormally) bifurcate. These are followed on each side by a single row of seven smaller teeth, the more anterior of which have the bases considerably broader than the tips. In each side of the maxillary is a series of about 35 teeth, in a single row, some in pairs, all smaller than those on the premaxillaries, but similar in form. The mandibular teeth in each half of the jaw are in two distinct series: an inner row of about 35 teeth set in the usual position along the bony ridge of the mandible, and an outer series of 5 well developed, widely spaced teeth placed on the outer surface of the anterior part of the jaw, entirely separated from the inner series. (In the adult fish, near the symphysis, only a single outer row is present, according to the type description). The teeth of both rows are of about the same size as those in the maxillary; the anterior ones of the inner row are irregularly spaced, while posteriorly they are in close-set groups of from 2 to 6, the teeth of each group decreasing in size backwards. On the vomer is one pair of strong teeth, and one small tooth is set far back on each palatine.

No trace of scales remains. The supraclavicular process is relatively smaller than in the preceding stages.

In all of the fins the individual rays are distinct. The pelvics are obliquely inserted and extend for about two-thirds of the distance between the bases of their most anterior rays and the origin of the anal fin.

The arrangement of the light organs is in agreement with Norman's description and figures (1930, p. 268, fig. 1, and Pl. II, fig. 3). The round, photophore-like mental organ beneath the tip of the lower jaw lies in the anterior end of a shallow trough and is directed

backwards and downwards. The trough is 2.1 mm in length, narrowing posteriorly, rimmed with luminous material and covered with a transparent, convex roof of tissue which projects below the surface of the surrounding skin. It is possible that the edges of the trough can be brought together, shutting off the light completely. Of all the luminous organs, this is by far the most highly developed.

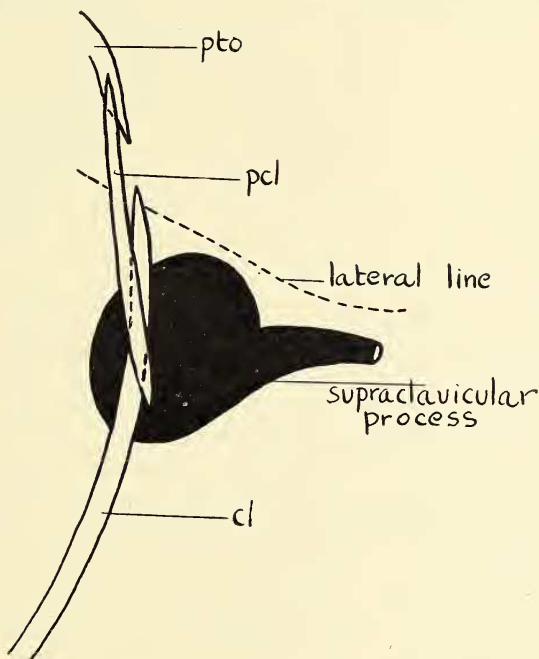


Fig. 10. *Bathytroctes rostratus* Günther. Diagram of supraclavicular process, showing its relation to pectoral girdle and lateral line. (From a cleared specimen 32 mm. in length.)

The organs of the isthmus and operculum shown in Norman's plate are found to be located on the branchiostegal rays: The most anterior three are on the left gill flap only, since this overlaps the right across the isthmus; posterior to this a single organ (which resembles an area of luminous tissue rather than a definite photophore) is found on each branchiostegal ray on both sides.

On the trunk the organs are arranged as in Norman's figure of a 47 mm fish. Those behind the pectorals and on the sides of the caudal peduncle, however, are exceedingly faint. This may be due either to damage or, as is more probable, to the fact that they are

already disappearing, since all of the light organs are supposedly absent in the adult. These faint photophores are just the ones omitted by Brauer in his plate (1906, Pl. XIII) of an 81 mm specimen. In the present example the two organs on the ventral surface immediately in front of the pelvic fins are connected by a narrow, white depression. The unpaired organ between the pelvics is not so distinct as that described by Norman, and its luminous spots seem to be on each side of it rather than before and behind it.

In cleared specimens the supraclavicular process is seen to be a retort-shaped sac, with a posteriorly directed neck terminating in a single pore. This seems to be the only opening, external or internal, to the organ, which arises just interior to the pectoral girdle at the junction of the supracleithrum and cleithrum, well below the lateral line. The posterior part of the sac and the entire neck are exterior to the body wall. It is possible that, instead of being greatly reduced in relative size in larger specimens, as is generally believed, the organ merely has a smaller part of its surface projecting exteriorly. (Figs. 9c and 10).

Osteology: In the 32 mm specimen the ossification is as a whole very slight, but is evident on the upper and lower jaws, teeth, vomer, quadrate, branchiostegal rays, gill-rakers, opercles, post-temporal, supracleithrum and cleithrum. Traces are found on the urostyle, but otherwise both the vertebral column and the fins are entirely unossified.

In the 38 mm specimen exactly the same areas are ossified, but more strongly, and in addition the parasphenoid shows a moderate degree of ossification.

The general structure of the skull closely resembles that of *Alepocephalus* (See Gregory 1933, fig. 51).

Digestive System (Fig. 11). The black, thick-walled stomach of the 56 mm. specimen is V-shaped, the apex being posteriorly directed. Its dorsal arm, from the end of the oesophagus to the apex, measures 7.8 mm; the lower arm, from apex to pylorus, 5.7 mm. Almost entirely surrounding the pylorus is a fringe of 23 short caeca. From here the whitish intestine extends straight backwards to the anus, except for one and one-half convolutions immediately in front of the pelvic fin. The liver is bi-lobed, each half extending partway up over the wall of the upper half of the stomach and the whole entirely filling the V formed by the curve of the stomach upon itself.

Reproductive System: The slender, ribbon-like ovaries extend from close behind the plane of the origin of the pectoral fin nearly to the anus. They lie flat against the dorsal wall of the coelom with a considerable space between them in the midline. The specimen

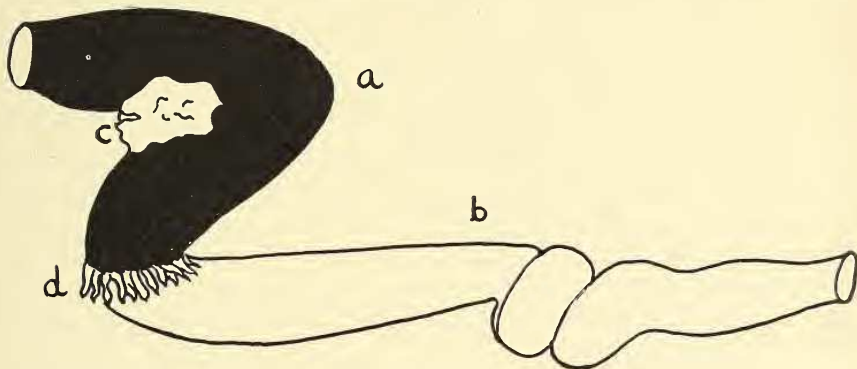


Fig. 11. *Bathytroctes rostratus* Günther. Alimentary canal, from a specimen 56 mm. in length. a, stomach; b, intestine; c, liver; d, caeca.

is obviously not in breeding condition, but about 200 minute eggs can be counted in each ovary.

SUMMARY OF DEVELOPMENT: The following résumés of the characteristics of each growth stage and of the order of their development are based upon a study of all of the specimens in the Bermuda collection.

Summary of the Changes Taking Place During Growth

Larva: 9.5 to 12.6 mm. Yolk sac present; jaws feeble, toothless; snout and head very short; eyes large, slightly elongate, obliquely set; caudal alone of the fins functionally well developed and it, like the dorsal and anal, still in the finfold stage; other finfolds persisting along anterior part of back and between yolk sac and anus; a third finfold possibly present between anterior and posterior dorsal folds; pectoral a fleshy pad; pelvic invisible; external portion of supraclavicular process proportionately longer than in later stages; pigment general, moderately dense except on nearly colorless head and fins; no light organs.

Transition: 10 to 14 mm. Traces of yolk sac remaining; jaws taking form; teeth appearing, with mandibular teeth uniserial and

on bony ridge only; snout and head proportionately longer than in larva, but still shorter than in adult; remains of finfolds and external urostyle; beginning of pectoral raylets; pelvic appearing; vertical finrays appearing.

Post-larva: 11 to 23 mm. No yolk sac; adult proportions of head established, or head and snout slightly longer than in adult; outer row of mandibular teeth appearing; premaxillary fangs slightly protruding, curved throughout length; other teeth few than in adolescent; pectoral with raylets and developing bases; pelvic about half developed, the bases of the rays distinct in the latter part of the stage; dorsal, anal and caudal fins entirely formed, the caudal forked; supraclavicular process proportionately shorter than in larva; beginning of mental photophore; no ossification; intestine without convolutions in posterior section; no caeca; reproductive organs distinguishable, but undeveloped.

Transition: 22 to 30 mm. All fins fully developed; ossification beginning on head and caudal base; beginning of branchiostegal and trunk photophores.

Adolescent: 28 to 56 mm. Extra-mandibular rows of teeth well developed, equal to or longer than those of the inner row, all of which still persist; first premaxillary tooth greatly enlarged, directed straight forward, with the tip alone slightly curved; dorsal fin a little further forward than in adult; light organs at maximum development; ossification present only on head, cleithrum and base of caudal; intestine convoluted in posterior portion, numerous caeca present; gonads not fully developed.

(*Adult*: From published descriptions. Extra-mandibular row of teeth persist, those corresponding to them on the bony ridge, lacking; no light organs).

ORDER OF DEVELOPMENT OF PRINCIPAL CHARACTERS

KEY:

..... Development rudimentary.

----- Half developed.

_____ Fully developed (i. e. in regard to appearance and proportions, but not in actual size).

	LARVA	POST-LARVA	ADOLESCENT
<i>Number of Specimens</i>	12	72	5
<i>Locality</i>	Bermuda	Bermuda	Bermuda
<i>Season</i>	May, June	April to Sept.	July to Sept.

ORDER OF DEVELOPMENT OF PRINCIPAL CHARACTERS—Continued

	LARVA	POST-LARVA	ADOLESCENT
Vertical Distribution	500 to 800 F.	500 to 1000 F.	800 to 1000 F.
Length	9.5 to 14 mm	11 to 30 mm	28 to 56 mm
Growth Characters:			
Size of external supra-clavicular process	_____	_____	_____
Yolk sac	_____	_____	_____
Profile finfolds	_____	_____	_____
Heterocercal caudal fold	_____	_____	_____
Homocercal caudal fin	_____	_____	_____
Pigment	_____	_____	_____
Eye, size and shape	_____	_____	_____
Head length	_____	_____	_____
Snout and jaws	_____	_____	_____
Dorsal and anal fins	_____	_____	_____
Pectoral fin	_____	_____	_____
Black, sac-like stomach	_____	_____	_____
Pelvic fin	_____	_____	_____
Teeth	_____	_____	_____
Photophores	_____	_____	_____
Caeca	_____	_____	_____
Intestinal convolution	_____	_____	_____
Development of gonads	_____	_____	_____
Ossification of skull	_____	_____	_____
Ossification of cleithrum	_____	_____	_____
Ossification of urostyle	_____	_____	_____

ECOLOGY

VERTICAL AND SEASONAL DISTRIBUTION: The accompanying table (Fig. 12) shows the vertical, monthly and yearly distribution of the specimens of *Bathytroctes rostratus* taken off Bermuda. The graph (Fig. 13) indicates that the majority of the specimens were taken between 600 and 800 fathoms, with an extreme range of 500 to 1000 fathoms. On the chart of the world distribution of the species (Fig. 7) the same data are given for comparison with the vertical distribution of previously recorded specimens.

Fig. 14 shows that the months of greatest abundance were May, July and September.

A study of the following table results in the conclusion that, unlike many other deep-sea fishes, there is no relationship discernible between month, depth, and length, although the youngest fish have been taken in the spring only, while the oldest of the specimens

occurred in summer and fall. (Fig. 15 gives the same data in graph form).

It will be noted that both the average monthly depth and the average monthly length show remarkably little variation.

Fathoms	April			May			June			July			Aug.			Sept.			Total		
	1929	1930	1931	1929	1930	1931	1929	1930	1931	1929	1930	1931	1929	1930	1931	1929	1930	1931	1929	1930	1931
400																					
500				1	1		2			1				1		1	3		4	5	1
				2			2			1			1			4			10		
600	1			4						2	1	1	1	1		4			3	10	2
	1			4						4			2			4			15		
700				1	6		2		1	5				1		1	5	1	4	16	3
				7			3			5			1			7			23		
800	1			1			2	1	1	6	6		1			1	2	1	12	9	2
	1			1			4			12			1			4			23		
900				1			1							1		3	1		4	2	1
				1			1						1			4			7		
1000	1			1			3			1	3					1	1		6	5	
	1			1			3			4						2			11		
Total	3			3	13		10	1	2	9	16	1	1	1	4	7	16	2	33	47	9
	3			16			13			26			6			25			89		

Fig. 12. *Bathytroctes rostratus* Günther. The vertical, monthly and yearly distribution of the specimens taken by the Bermuda Oceanographic Expeditions.

SOCIABILITY: *Bathytroctes rostratus* does not seem to be gregarious even in the larval and post-larval stages. In the majority of cases the Bermuda specimens occurred singly in the nets, in

eight nets only were there two specimens found together, in one three and in one four. In the last case one larva was found with three young post-larvae, while in another a 13 mm fish was found with one of 21 mm and a 22 mm specimen with one of 32 mm; in

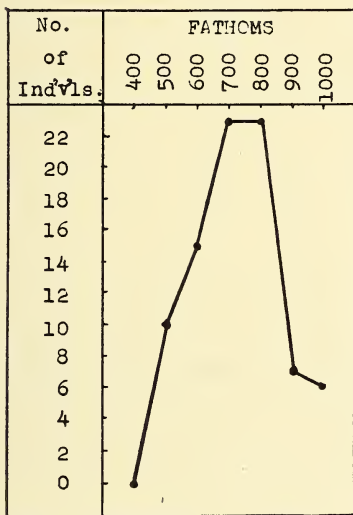
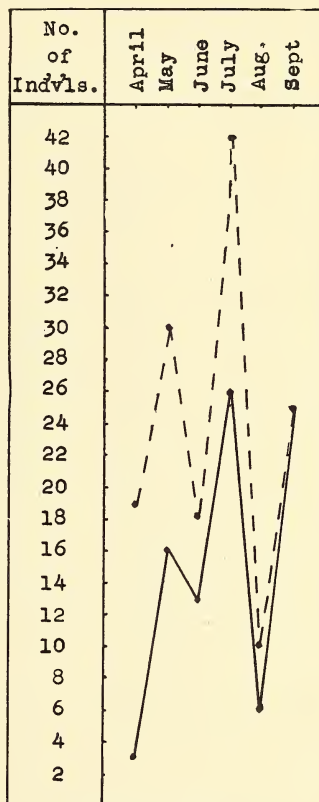


Fig. 13. (Left). *Bathytroctes rostratus* Günther. The vertical distribution of the specimens taken by the Bermuda Oceanographic Expeditions.

Fig. 14. (Right). *Bathytroctes rostratus* Günther. The seasonal distribution of the specimens taken by the Bermuda Oceanographic Expeditions. The solid line is based upon the actual number of specimens taken; the broken line upon the number which would theoretically have been caught if as many nets had been drawn every month as during September.¹



the remaining cases the specimens appearing together were of approximately the same size and stage of development. However, it seems probable that these isolated instances of apparent sociability are accidental: It must be remembered that each net was drawn through the water for a period of four hours or more. All previously recorded specimens seem to have been taken singly.

¹ See Introduction, p. 7.

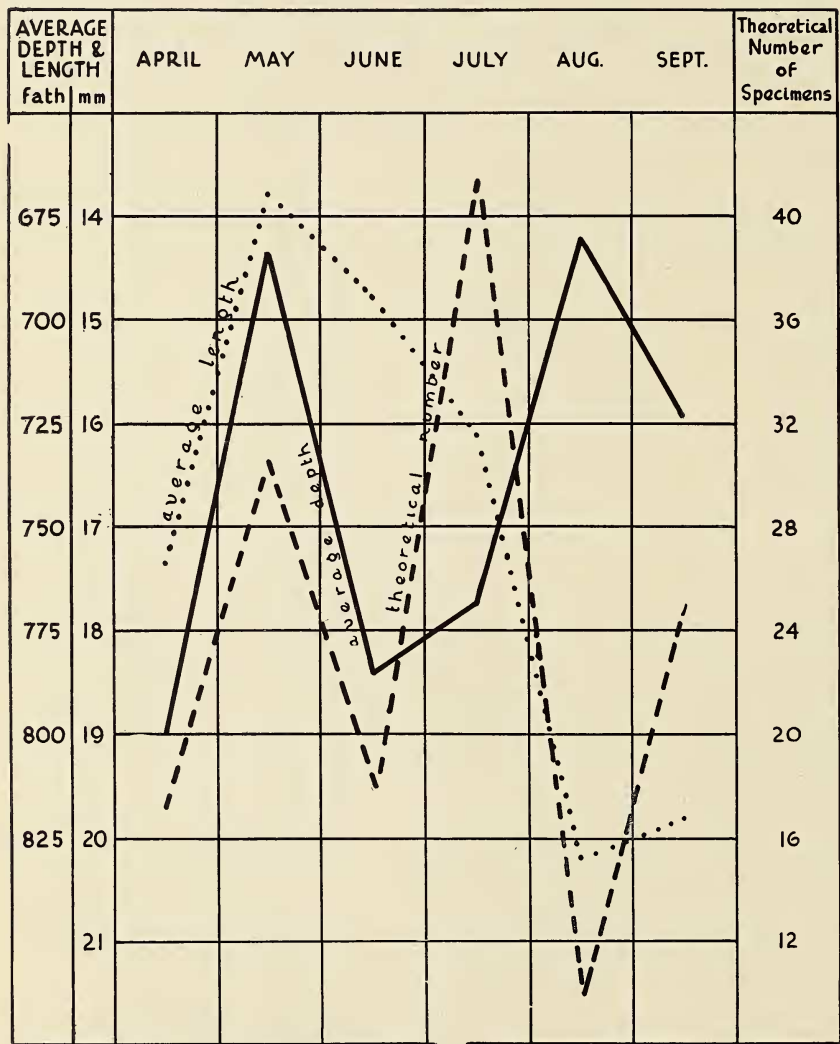


Fig. 15. *Bathytroctes rostratus* Günther. The relation of month of capture to average length (dotted line), average depth (solid line) and theoretical numerical abundance¹ (broken line), all based on the total number of specimens taken by the Bermuda Oceanographic Expeditions.

¹ See fig. 14 and Introduction. p 7.

RELATION OF MONTH, NUMBER OF SPECIMENS, DEPTH,
LENGTH AND GROWTH STAGE

Month	Number	Depth in Fath.:		Length in mm:		Growth Stages
		Extremes	Average	Extremes	Average	
April	3	600-1000;	800	12 to 21;	17.3	Post-larval
May	16	500-1000;	687	10 to 25;	13.8	Larval, Post-larval
June	13	500-1000;	785	10 to 25;	14.8	Larval, Post-larval
July	26	500-1000;	769	10 to 38;	16.1	Post-larval, Adoles- cent
Aug.	6	500- 900;	683	14 to 36;	20.2	Post-larval, Adoles- cent
Sept.	25	500-1000;	724	10 to 56;	19.8	Post-larval, Adoles- cent
Total	89	500-1000;	739	10 to 56;	16.1	Larval, Post-larval, Adolescent

ABUNDANCE: *Bathytroctes rostratus* is uncommon among the deep sea fish taken off Bermuda. It occurred in 7.1 per cent of all of the nets drawn between 500 and 1000 fathoms, the limits of its vertical distribution in this area.

FOOD: The stomach contents of six specimens consisted entirely of the remains of crustaceans, distributed as follows:

<i>Length of Specimen</i>	<i>Contents of Stomach</i>	<i>Depth</i>
15 mm	1 well digested Copepod	500 Fath.
15 mm	Finely digested Crustacean	800 Fath.
17 mm	Empty	700 Fath.
25 mm	1 Copepod	900 Fath.
	1 <i>Sapphirina</i>	
32 mm	Empty	900 Fath.
56 mm	1 Shrimp	1000 Fath.
	1 <i>Sapphirina</i>	
	1 Gammarid	

STUDY MATERIAL

The following list gives the catalogue number, depth in fathoms, date, length and growth stage of each specimen of *Bathytroctes rostratus* taken by the Bermuda Oceanographic Expeditions. All were caught in the cylinder of water off the Bermuda coast described on p. 5. "Lar. Trans." indicates the Transition Stage between Larva and Post-Larva. "P-lar. Trans." indicates the Transition Stage between Post-larva and adolescent.

No. 8,827a;	Net 22;	600 F.;	April 15, 1929;	21 mm;	Post-larva.
No. 9,576;	Net 35;	800 F.;	April 24, 1929;	12 mm;	Post-larva.
No. 9,604;	Net 44;	1000 F.;	April 25, 1929;	19 mm;	Post-larva.
No. 9,743;	Net 60;	500 F.;	May 3, 1929;	13 mm;	Larva.
No. 10,102;	Net 131;	800 F.;	May 27, 1929;	25 mm;	P.-lar. Trans.
No. 10,245;	Net 136;	700 F.;	May 30, 1929;	14 mm;	Post-larva.
No. 10,397;	Net 158;	500 F.;	June 12, 1929;	14, 15 mm;	Lar. Trans. & Post-larva.
No. 10,426;	Net 169;	1000 F.;	June 14, 1929;	15, 15, 15 mm;	Post-larvae.
No. 10,497;	Net 174;	900 F.;	June 15, 1929;	25 mm;	P.-lar. Trans.
No. 10,702;	Net 196;	800 F.;	June 20, 1929;	17 mm;	Post-larva.
No. 10,819;	Net 207;	700 F.;	June 22, 1929;	13, 13 mm;	Post-larvae.
No. 11,135;	Net 241;	800 F.;	June 29, 1929;	14 mm;	Post-larva.
No. 11,188;	Net 245;	800 F.;	July 1, 1929;	15 mm;	Post-larva.
No. 11,243;	Net 251;	800 F.;	July 4, 1929;	15 mm;	Post-larva.
No. 11,356;	Net 267;	600 F.;	July 8, 1929;	17, 17 mm;	Post-larvae.
No. 11,385;	Net 275;	800 F.;	July 9, 1929;	13 mm;	Post-larva.
No. 11,399;	Net 277;	1000 F.;	July 9, 1929;	14 mm;	Post-larva.
No. 11,442;	Net 281;	800 F.;	July 10, 1929;	10 mm;	Lar. Trans.
No. 11,868;	Net 329;	800 F.;	July 27, 1929;	15, 15 mm;	Post-larvae.
No. 12,335;	Net 375;	800 F.;	Aug. 15, 1929;	36 mm;	Adolescent.
No. 12,890;	Net 407;	900 F.;	Sept. 2, 1929;	15 mm;	Post-larva.
No. 12,973;	Net 412;	800 F.;	Sept. 3, 1929;	21 mm;	Post-larva.
No. 13,061;	Net 418;	700 F.;	Sept. 4, 1929;	17 mm;	Post-larva.
No. 13,081;	Net 421;	1000 F.;	Sept. 4, 1929;	56 mm;	Adolescent.
No. 13,467;	Net 466;	900 F.;	Sept. 12, 1929;	22, 32 mm;	P.-lar. Trans. & Adolescent.
No. 13,571;	Net 478;	500 F.;	Sept. 20, 1929;	9.5 mm;	Lar. Trans.
No. 14,723;	Net 542;	900 F.;	May 6, 1930;	13 mm;	Post-larva.
No. 14,730;	Net 539;	600 F.;	May 6, 1930;	15 mm;	Post-larva.
No. 14,791;	Net 547;	1000 F.;	May 7, 1930;	15 mm;	Post-larva.
No. 14,829;	Net 553;	700 F.;	May 9, 1930;	12 mm;	Post-larva.
No. 15,063;	Net 589;	700 F.;	May 17, 1930;	9.5, 11, 12, 13 mm;	Larva & 3 Lar. Trans.
No. 15,204;	Net 596;	600 F.;	May 19, 1930;	11 mm;	Post-larva.
No. 15,279;	Net 618;	500 F.;	May 22, 1930;	16 mm;	Post-larva.
No. 15,349a;	Net 627;	600 F.;	May 23, 1930;	13 mm;	Post-larva.
No. 15,452;	Net 638;	600 F.;	May 28, 1930;	12 mm;	Post-larva.
No. 15,518b;	Net 647;	700 F.;	May 29, 1930;	15 mm;	Post-larva.
No. 16,301;	Net 738;	800 F.;	June 28, 1930;	9.5 mm;	Larva.
No. 16,442;	Net 754;	700 F.;	July 1, 1930;	12, 15, 16 mm;	Post-larvae.
No. 16,448;	Net 755;	800 F.;	July 1, 1930;	11 mm;	Lar. Trans.
No. 16,937;	Net 757;	1000 F.;	July 1, 1930;	38 mm;	Adolescent.
No. 16,683;	Net 759;	700 F.;	July 2, 1930;	15 mm;	Post-larva.
No. 16,595;	Net 765;	500 F.;	July 3, 1930;	17 mm;	Post-larva.

No. 16,610;	Net 767;	800 F.;	July 3, 1930;	12, 13 mm;	Lar. Trans. & Post-larva.
No. 16,657;	Net 775;	1000 F.;	July 4, 1930;	12 mm;	Post-larvae.
No. 16,722;	Net 778;	700 F.;	July 5, 1930;	19 mm;	Post-larva.
No. 16,873;	Net 796;	1000 F.;	July 9, 1930;	17 mm;	Post-larva.
No. 17,010;	Net 798;	600 F.;	July 15, 1930;	13 mm;	Post-larva.
No. 17,044;	Net 800;	800 F.;	July 15, 1930;	13, 21 mm;	Post-larvae.
No. 17,205;	Net 807;	800 F.;	July 16, 1930;	28 mm;	Adolescent.
No. 17,418;	Net 810;	600 F.;	Aug. 28, 1930;	14 mm;	Post-larva.
No. 17,624;	Net 830;	700 F.;	Sept. 2, 1930;	19 mm;	Post-larva.
No. 18,075;	Net 860;	600 F.;	Sept. 8, 1930;	14 mm;	Post-larva.
No. 18,084;	Net 861;	700 F.;	Sept. 8, 1930;	16 mm;	Post-larva.
No. 18,100;	Net 862;	800 F.;	Sept. 8, 1930;	29 mm;	P.-lar. Trans.
No. 18,301;	Net 866;	700 F.;	Sept. 10, 1930;	16, 16 mm;	Post-larvae.
No. 18,448;	Net 880;	500 F.;	Sept. 12, 1930;	17 mm;	Post-larva.
No. 18,504;	Net 884;	800 F.;	Sept. 13, 1930;	14 mm;	Post-larva.
No. 18,514;	Net 887;	900 F.;	Sept. 13, 1930;	23 mm;	Post-larva.
No. 18,604;	Net 890;	600 F.;	Sept. 15, 1930;	17 mm;	Post-larva.
No. 18,698;	Net 902;	700 F.;	Sept. 17, 1930;	12 mm;	Post-larva.
No. 18,975;	Net 921;	500 F.;	Sept. 20, 1930;	30 mm;	P.-lar. Trans.
No. 19,116;	Net 923;	600 F.;	Sept. 20, 1930;	13 mm;	Lar. Trans.
No. 19,041;	Net 927;	500 F.;	Sept. 22, 1930;	19 mm;	Post-larva.
No. 19,213;	Net 933;	600 F.;	Sept. 23, 1930;	15 mm;	Post-larva.
No. 19,447;	Net 953;	1000 F.;	Sept. 26, 1930;	16 mm;	Post-larva.
No. 20,554;	Net 985;	700 F.;	June 2, 1931;	11 mm;	Post-larva.
No. 20,665;	Net 1001;	800 F.;	June 5, 1931;	15 mm;	Post-larva.
No. 21,719;	Net 1109;	600 F.;	July 27, 1931;	16 mm;	Post-larva.
No. 21,932;	Net 1137;	600 F.;	Aug. 6, 1931;	15 mm;	Post-larva.
No. 21,953;	Net 1139;	700 F.;	Aug. 6, 1931;	26 mm;	P.-lar. Trans.
No. 22,542;	Net 1193;	500 F.;	Aug. 18, 1931;	15 mm;	Post-larva.
No. 22,717;	Net 1213;	900 F.;	Aug. 21, 1931;	13 mm;	Post-larva.
No. 23,180;	Net 1272;	700 F.;	Sept. 7, 1931;	17 mm;	Post-larva.
No. 23,581;	Net 1316;	800 F.;	Sept. 17, 1931;	20 mm;	Post-larva.

Nos. 13,467a (KOH No. 1145), 14,730 (KOH No. 865), 16,937 (KOH No. 863) and 19,116 (KOH No. 1146) have been cleared and stained in order to study the skeleton. The following outline drawings are filed: B733, B733a, B870-875 incl.

SYNONYMY AND REFERENCES

Bathytroctes rostratus

Günther 1878, p. 250. (1 specimen; 6.5 in; 675 fath.; off Pernambuco; *type specimen*).

Günther 1887, p. 227, pl. LVIII, fig. 13. (Supplementary description of type specimen).

- Goode and Bean 1895, p. 41. (Résumé of type description).
Koehler 1896, p. 516. (1 specimen; length questionable; 1700 m.; Bay of Biscay).
Brauer 1906, p. 17, pl. XLV, figs. 2, 3. (1 specimen; 81 mm; 2000 m.; between Cocos and Sumatra).
Holt and Byrne 1908, p. 45, pl. IV, figs. 3, 4, 5. (6 specimens; 10 to 32 mm; 650 to 1000 fath.; west coast of Ireland).
Zugmayer 1911, p. 5, pl. I, fig. 1. (7 specimens; 14 to 150 mm; 4750 (to 0) m.; Mediterranean and Coast of Portugal).
Murray and Hjort 1912, p. 394, pl. IX. (2 or more specimens; 9 to 52 mm; south of Azores and off Tangier).
Barnard 1925, p. 122. (1 specimen; ca. 165 mm (?); 700 fath.; off Cape Point, South Africa).
Norman 1930, p. 268, pl. II, fig. 3. (4 specimens; 30 to 47 mm; 350 to 1000 m.; off Cape Town).
Roule and Angel 1933, p. 6. (7 specimens; up to 155 mm; (0) to 3000 m.; Eastern Atlantic, Bay of Biscay to Madeira).

Bathytroctes proroscopus

- Brauer 1902, p. 43. (5 specimens; 11.5 to 17 mm; 1500 to 2000 m.; Indian Ocean. Synonymized with *B. rostratus* by Brauer in 1906).

Genus *Dolichopteryx* Brauer 1901

GENERIC CHARACTERS: Form elongate, almost cylindrical; scales, when present, rudimentary; eyes probably always telescopic; snout long with a small mouth at the tip; teeth, when present, in either upper or lower jaw or in both; branchiostegals 2; paired fins well developed, moderately close to ventral profile; dorsal originating in front of anal, both fins short, in posterior part of body.

The character of the skull and opercles, and the structure of the jaws in particular, unquestionably place the genus among the Isospondyls, and not with the Iniomi as suggested by Roule and Angel (1930, p. 75), and I agree with Brauer (1906, p. 24-25) and Norman (1930, p. 271) that it should be included in the family *Alepocephalidae*.

NUMBER OF SPECIES; DISCUSSION OF SYNONYMY: Three species—*D. longipes* (Vaillant 1888), *D. anascopa* Brauer 1902, and *D. binocularis* Beebe 1932—have been described, of which perhaps only the first and last are valid. The table on p. 58 lists the com-

parable data available for each of the specimens of the genus which have been previously recorded, as well as for those of the present series. From this table it is apparent that both of Norman's specimens (1930, p. 271) and the 52 mm *Dolichopterygiella* of Roule and Angel (1930, p. 73; total length 58 mm) approach *D. binocularis* in their slenderness, small heads, and elongate paired fins, while the remaining specimens of the series are, allowing for differences in size, comparatively homogeneous in their greater depths and longer heads. The fact that one of the Bermuda specimens, only 35 mm in length, is not far from breeding condition and has the skeleton well ossified makes it probable that Norman is over-stressing the small size of Vaillant's and Brauer's specimens in order to explain the lack of agreement between the proportions of their fish and his. Also, the differences among the four Bermuda specimens described in the coming pages as *longipes* do not seem to be sexual. Hence the existence of still another species among the known specimens of the genus is possible, although this point cannot be decided until all of these recorded examples have been examined at one time after additional material has been secured.

In the compilation of the table it was occasionally necessary, for the sake of uniformity, to calculate the standard length and certain proportions of a specimen from the drawing accompanying the description. For example, Roule and Angel (1930, p. 69 ff) have sometimes employed the standard length and sometimes the total as the basis for their calculations of proportions.

Their 25 mm specimen (ibid. p. 70, pl. IV, fig. 90), of the *Dolichopterygiella* series is omitted from the table because, in comparison with the 23 mm Bermuda adolescent described in the present paper (Fig. 20A), it seems impossible that the former young fish can belong to the genus *Dolichopteryx*. The following are the principal objections: The specimen of Roule and Angel lacks pelvics (although they are described as present in the 8 mm specimen of the same series) while they are well developed in my fish of comparable size; similarly, telescopic eyes, a well developed anal fin and characteristically deep caudal peduncle are all found in my specimen, though lacking in the *Dolichopterygiella*. Finally, the anterior position of the dorsal fin and the shape of the snout in the drawing of the latter fish suggest that this may be, instead, a young argentinid.

GEOGRAPHICAL DISTRIBUTION: *Dolichopteryx* has been reported

THE RECORDED SPECIMENS OF *Dolichopteryx*

Authority	Standard Length in mm	Length Depth	Length Head	Head Eye	Head Snout	Snout-Pelvic Pelvic-Caudal	Pectoral Rays
1. Norman 1930	120	12	4.5	?	?	3.5	14
2. Norman 1930	100	12	4.5	?	?	2.4	14
3. Bermuda Specimen	85	8.5	2.4	7.7	2.1	2.2	14
4. Roule & Angel 1930	74	7.4	3.2	7	2.2	2.7	?
5. Roule & Angel 1930	52	13	5	6.8	2.6	3.3	14-15
6. Roule & Angel 1930	51	7.8	3.6	8	2.1	2	?
7. Roule & Angel 1930	48	8.5	3.5	7	2	1.8	13-14
8. Vaillant 1888	45	9	3	8	2.4	2	?
9. Roule & Angel 1930	40	9	4	6	2	1.8	13-14
10. Bermuda Specimen	40	9.3	3.5	6.7	2.4	2.2	13
11. Bermuda Specimen	35.5	7.7	2.5	10	2.3	2.1	13
12. Brauer 1906	34.8	10	3.2	6.2	2.1	1.75	14
13. Bermuda Specimen	23	9.6	3.1	10.6	2.2	1.7	13
14. Roule & Angel 1930	8	10	5	?	short	?	?
15. Beebe 1932 (<i>D. binocularis</i>)	85	17	5	5.5	2.4	3.7	14

Pelvic Rays	Dorsal Rays	Anal Rays	Eyes	Teeth	Location
1. 12	15?	12	?	Present at least in upper jaw	Off Cape Town
2. 12	15?	12	?	Present at least in upper jaw	Off Liberia
3. 9	11	10	Telescopie	Bands in upper jaw; single row in lower	Bermuda
4. ?	12	?	Telescopie	?	N. of Teneriffe
5. 8-9	15	10	Telescopie	?	Off Madeira
6. ?	11	9	Telescopie	?	Monaco Deep
7. 10	12	9	Telescopie	?	N. of Teneriffe
8. 6	5?	9+	Normal?	?	Off Morocco
9. 8	9-10	8-9	Telescopie	?	Off Funchal
10. 9	11	9	Telescopie	Bands in upper jaw; single row in lower	Bermuda
11. 11	11½	10	Telescopie	Bands in upper jaw; single row in lower	Indian O. off Cocos
12. 12	10?	12	Telescopie	None	Bermuda
13. 9	10	?	Telescopie	Bands in upper jaw; single row in lower	W. of Canaries
14. present	?	?	?	?	Bermuda
15. 9	14	10	Telescopie	Bands in upper jaw; single row in lower	Bermuda

from the North and South Atlantic and the Indian Oceans. (Fig. 19).

VERTICAL DISTRIBUTION: The genus has been taken between 191 and 2187 fathoms (350 and 4000 meters), the Bermuda specimens occurring between 400 and 800 fathoms (732 and 1463 meters). Between the latter depths temperatures in the trawling cylinder range between 63.1° and 40° Fah. (17.3° and 10.3° Cent.).

ABUNDANCE AND SOCIABILITY: Although only 15 specimens of this genus, including the 5 of the Bermuda series, have ever been taken, in two cases 2 specimens were caught in the same net.

VIABILITY: Not only has no *Dolichopteryx* ever been recorded as taken alive, but it is one of the most delicate of deep-sea fishes, few of the specimens having been caught in good condition.

***Dolichopteryx binocularis* Beebe 1932**

TYPE: (Fig. 16). Department of Tropical Research No. 21,867; Bermuda Oceanographic Expeditions of the New York Zoological Society; Net 1125; August 4, 1931; 14 miles south-east of Nonsuch Island, Bermuda; 400 fathoms; Standard length 85 mm.

MEASUREMENTS AND COUNTS: Total length 101 mm; standard length 85 mm; depth 5 (in length 17); head 17 (in length 5); eye diameter 3.1 (in head 5.5); snout 7.1 (in head 2.4); pectoral rays 6 + 8 = 14; pectoral length 55; pelvic rays 3 + 6 = 9; pelvic length 15; dorsal rays 15; anal rays 11; caudal rays XIII + 10 + 9 + XIII.

GENERAL DESCRIPTION: The recently caught fish as a whole appears as transparent white, with dark muzzle, five large, ventral blotches, and a midline of dark chromatophores. The upper lip is white, the jaws solidly dusky, thinning into individual, black, round chromatophores back almost to the eyes; this pigment is close over the bone of the jaws, far beneath the outer, white, transparent skin; directly below the eyes are fourteen large, purplish dendritic chromatophores, six in a straight row, the others in a bow shape below; on the side of the midbrain and back of the hind brain are solid masses of almost fused, black chromatophores; a large, triangular patch of many, very small ones over the lower angle of the gill arches; another large patch of disconnected ones directly over the heart which lies just below the pectorals; on the ventral surface are five dense patches of black showing purple glints; the fourth merges with

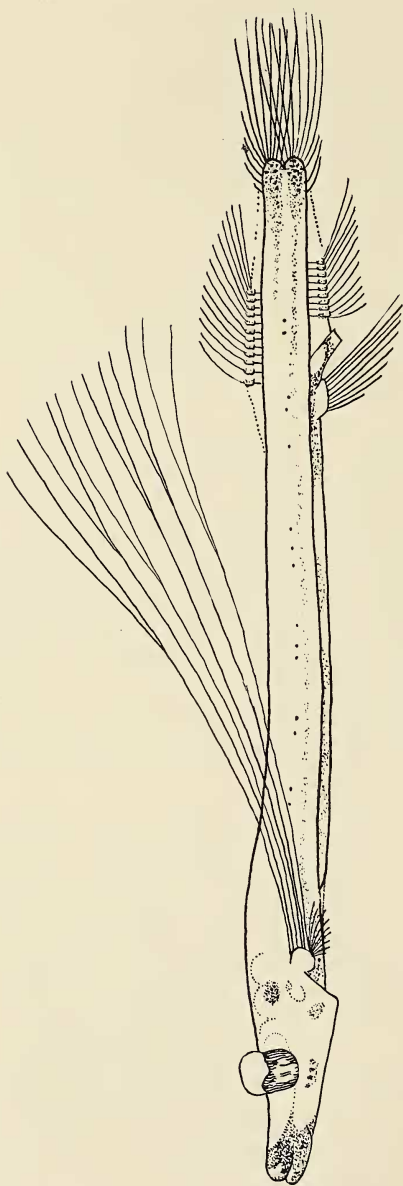


Fig. 16. *Dolichopteryx binocularis* Beebe. $\times 1.5$.

the fifth far back beneath the ventrals; along the midline of the body a single row of iridescent or black chromatophores; these are arranged into successive groups, the more anterior of three to five chromatophores; from the midbody back the groups increase in number of components—five to ten—each group forming a short, oblique line, at a slight downward angle; midway between this line and the back is a second line of a very few, widely spread, large chromatophores, twenty-two altogether, quite irregular as regards spacing, two together or singly; from halfway between the end of the dorsal and the caudal the parallel-sided peduncle is thickly peppered with large and small, separate, dendritic chromatophores, there being a clear space along the midline.

The body is greatly elongate, almost cylindrical, with the dorsal and ventral surfaces nearly parallel. The head narrows slowly into a broad, rounded muzzle. The eyes, once and a half as high as wide, project well above the profile and are slanted forward 10° from the vertical. Separated from each other only by the narrow, spine-like forward projection of the frontal, they rest in a great depression much larger than the eyeballs themselves, the upper part covered with perfectly transparent tissue. The eye stalks are thick, short, dark, the summits clear, swollen, rounded. The eyeballs are overlaid on the front and outer side with longitudinal, prismatic, spicule scales, giving off blue, green and bronze reflections, while their bases rest in shallow saucers of silver spicules. On the outside the black of the eyeball extends upward in a rounded bay, which carries a large, pale white photophore, opening obliquely down and back in a silvery trough. The nostrils are round, close together, and about a quarter of the distance between the tip of the snout and the anterior margin of the eye. The mouth is very small, horizontal.

There is a single series of about 30 very small, close-set, incurved teeth in the mandible. In the upper jaw there are four to five rows of teeth. Externally, on the cleared, outer surface of the lips and jaw the bases of these can be distinguished as separately ossified, mosaic-like, irregularly arranged crescents or kidney-shaped bony plates. Within the jaw each of these gives rise to a long, recurved tooth, all of which teeth lie flat in a solid mass against the roof of the jaw.

In the dyed and cleared specimen a row of 58 lateral line scales

(Fig. 17) is visible extending from the opercle to the caudal, a second, incomplete row below this on the caudal peduncle and a third very short row behind the opercles.

In the first row, the first scale, just above the base of the dorsal pectoral rays, is a well-ossified, thick, half circle, opening backward. The next 26 are very small, thin, slightly ossified and irregular, some almost straight, others three-fourths of a circle. The 27th scale occurs at 18.6 mm in front of the dorsal. From here

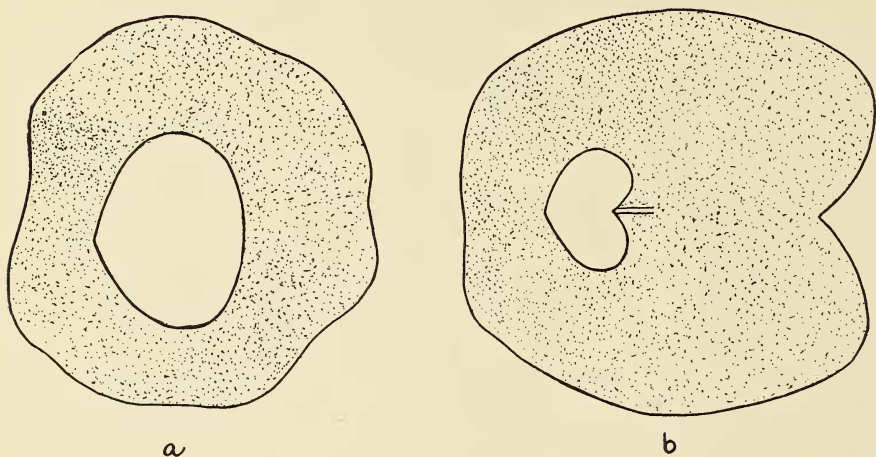


Fig. 17. *Dolichopteryx binocularis* Beebe. Scales from lateral line; a, from the vertical at origin of dorsal fin; b, from base of caudal fin. ($\times 58$).

on the scales increase in size and thickness, and become circular. At the 40th, just over the ventral fins, they reach their largest size, the diameter keeping even for the succeeding scales to the last at the very base of the caudal. These are .86 mm in outside, vertical diameter with a central, oval opening .5 mm in length. From the 40th on, the posterior rim of the central opening shows a slight thickening of osseous tissue, which increases and concentrates toward the center until in the 51st, a slight projection is visible. In the last five this extends clear across the central hole as a knob-shaped projection, and a low spine develops on the outside.

Anteriorly the scales are five or six of their diameters apart, but they gradually approach until posteriorly the edges slightly overlap. They are placed equidistantly between the row of isolated

chromatophores, and the inferior, dense line. And now we see that each curve, or oblique row marks an individual scale, this being true even to the very first. The clear midline space in the pigmented peduncle is now explained, for it is quite filled up with the lateral line scales.

There is a second, incomplete row of scales, beginning between the 40th and 41st, and extending to the caudal. These are placed close beneath the oblique line of chromatophores, alternate with the upper row, and are much smaller, almost round and solid. These round scales are smaller anteriorly and increase slightly in size backward. There is a short row of 5 scales, similar to these, above the line of scattered chromatophores extending a short distance along the sides from the opercles. All the scales are very delicate and deciduous, a few falling off at each change of fluid in the clearing process.

The 14 rays of the pectoral are divided into two distinct groups, the upper 6 of great length, reaching to the middle of the anal, and the lower 8 only about one-fourteenth as long. The first group were, in the fresh fish, directed straight back or slightly upward, and in this individual, new-caught fish the first and sixth left rays and the first and third right rays were bent but still showed full length. They split into two about half-way of their length. The lower eight were directed obliquely downward. The rays arise from a large, fleshy, basal pad, with a sharply oblique, posterior rim. The pelvics, too, have a conspicuous base and the rays reach the base of the caudal. In the cleared tissue they are seen to be divided sharply into two divisions, six lower, very fine rays, close together, and three superior rays, placed farther apart and more than twice as stout as the others. Their insertion is well in front of the vertical from the dorsal origin, 3.7 times nearer the base of the caudal than the tip of the snout. The dorsal fin arises high above the surface of the body, from a framework supporting an oval muscle and a tall baseost for each ray except the first and last; forward the free skin stretches for a considerable distance, and posteriorly the high, free, transparent skin connects with the supracaudal spines; the anal, arising under the 12th dorsal ray, is similar, and the muscles of each fin have a scattering of black chromatophores along their sides. The caudal is slightly forked.

In addition to the orbital photophore described above, a second

luminous organ extends along the ventral surface of the body: the epidermis from the gills to the anus is loose, suspended by numerous thread-like supports, carrying an opaque band of luminous tissue; this organ gleamed only with the faintest sheen in the new caught specimen; when dyed and cleared it was found to have a large number of very small tubercles.

OSTEOLOGY

SKULL: (Fig. 18). The skull of *Dolichopteryx binocularis* is characterized by thin, lightly ossified bones, showing only a few foci of stronger structure, as along the dental ridge and at the quadrato-articular joint. Several elements, however, such as the preopercular, have central, high thin plates of bone, arising at right angles to the main plane. The chief specialization is the extreme antero-posterior extension of the skull, and the small, terminal mouth, recalling in a very general way, the skull ground plan of *Opisthoproctus*.

The top of the cranium shows the dominance of the fused frontals occupying fully four-fifths of the superiorly visible ossification. The cranium itself is almost completely roofed by these frontal bones. It is roughly six-sided, with the anterior aspect curving widely around the immense orbits. The forward extension of the skull is formed solely by the long, slender, almost spine-like bone of the fused frontals, which is five times the length of the cranium. On each side of this elongate bone is a prominent up-turned wing or rim, almost as if the outer edges of the frontals had been elevated to make more room for the great eyes. Beneath the same frontal rod is a transparent, median, cartilaginous septum, extending back to the vertical of the upturned eyeballs. Four-fifths of the way toward the tip of the snout, the faintly ossified prefrontals may be seen extending vaguely downward on each side of the main frontal stem. Some distance from the tip the mesethmoids appear as a very thin, overlying sheet, and through them the anterior ends of the frontals are visible, here for the first time recognizable as two slender splinters, lying side by side.

The premaxillaries form a broad bony lip about the mouth and the superior ends of the maxillaries are seen, sloping steeply downward and back.

The second largest bones of the cranium are the pterotics, long, irregular oblongs, separated by a well-marked open suture from the

whole lateral aspect of the frontals. At their anterior ends arise small, angular sphenotics, taking a small share in the bounding of the orbits. The parietals, equal to the sphenotics in size, are ill-defined, but lie between the postero-lateral curve of the frontals and the pterotics. The supra-occipital shows a small, rounded base, and a posteriorly directed spine. The epiotics are not nearly as well defined as some of the other bones, but project from the postero-lateral cranial profile, as two rounded lobes. Over them extend the elongate post-temporals, forming a close, overlapping joint with the supra-cleithra.

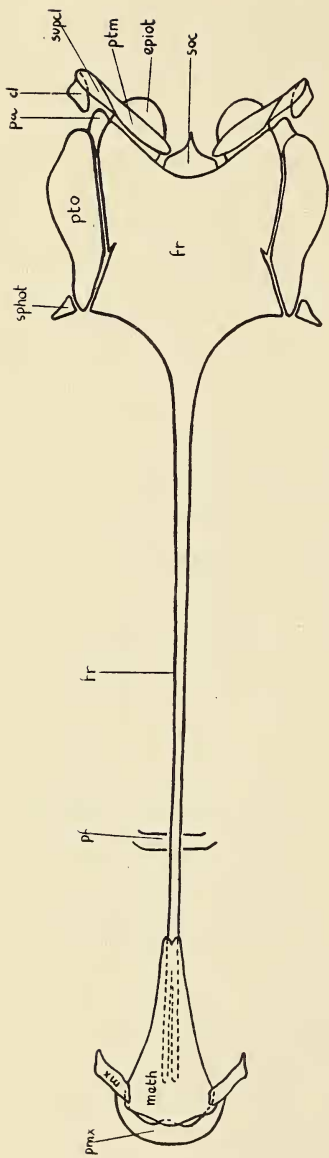
The lateral view of the skull shows all the above bones in clearer relationship, the pterotic nearly vertical, and bordering the whole lateral cranium. Beneath it is a small, unidentified, crescentic ossification in the midst of a large, irregular, unossified area.

A long, slender parasphenoid, similar in diameter to the elongate frontal spine, bounds the enormous optic lobes, extending from mid-mesethmoid backward in an easy double curve, and disappearing behind the hyomandibular. The prefrontal is seen to be fairly well ossified, but with vanishing ends above and below.

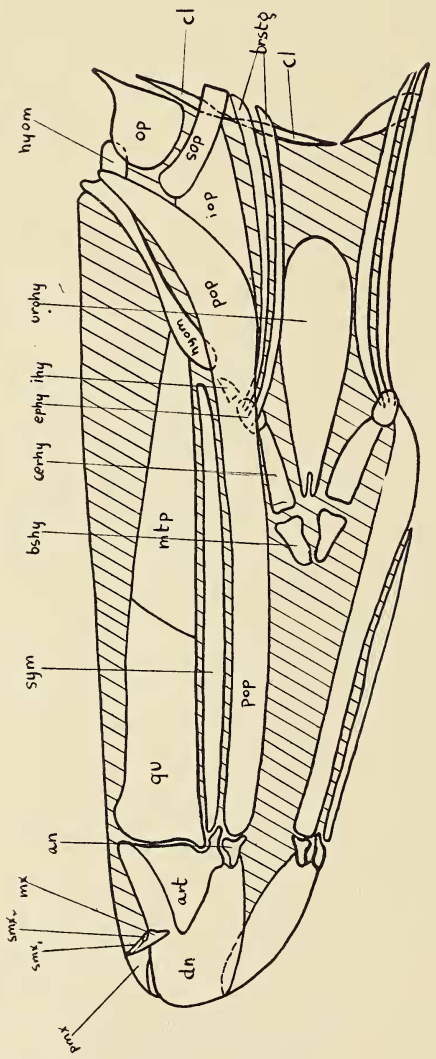
PALATO-PTERYGOID ARCADE: The hyomandibular, like all the bones, is almost transparent and only by careful lighting and focusing can be satisfactorily differentiated from the partly overlying preopercle. It is shaped roughly like a mammalian femur, with large, superior, rounded, double heads, one extending interior to the sphenotic and pterotic, and the other holding the same relation to the upper, anterior rim of the opercle. The shaft of the hyomandibular extends forward and downward and makes three contacts, one with the metemapterygoid, one with the symplectic and one with the interhyal. The symplectic is a long, slender rod reaching far forward, ventral to the metemapterygoid and quadrate, almost to the hinge of the jaw.

JAW APPARATUS: The jaw bones are well ossified. The premaxillaries are separated medially by the slightest of sutures. Their posterior ends disappear beneath the maxillaries, which cross them at an oblique downward and back angle. The mid-posterior portions of these bones are occupied by two supra-maxillaries. The teeth have been described elsewhere.

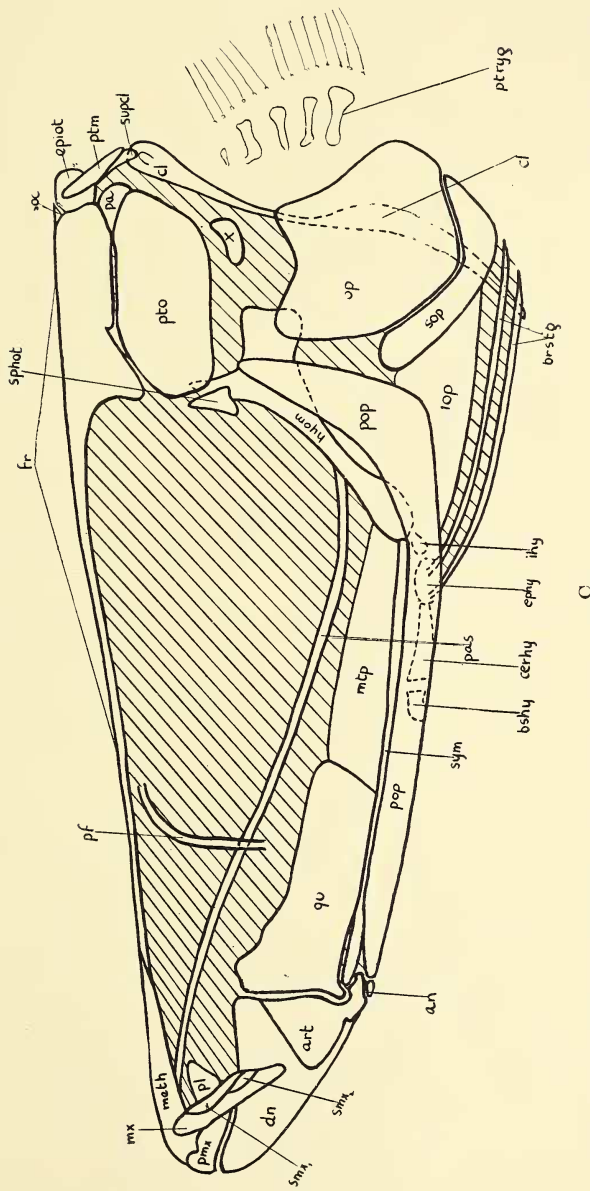
The mandible is heavy and deep, the upper profile straight, and the posterior almost so. The articular is faintly separated,



A



B



C
Fig. 18. *Dotichopteryx binocularis* Beebe. Skull, hyoid arch and opercular bones. A, dorsal view; B, latero-ventral view; C, lateral view.

comprising one-third of the infero-posterior area; the angular is small, very irregular and wholly ventral to the quadrate articulation.

OPERCULAR BONES: The opercles, thin as they are, are solid to their boundaries, and show none of the posterior comb-like structures so conspicuous in *Alepocephalus* and *Bathylagus*.

The opercle is irregularly circular, and is bounded on the upper and anterior faces by wide, unossified areas. Along the lower curves, the subopercle fits closely, the latter bone being roughly L-shaped. The preopercle begins exterior to the upper end of the hyomandibular and passes down over that bone, then bends abruptly forward, and extends as a wide heavy shaft almost to the angular, its anterior end actually excavated to fit loosely the posterior face of the angular. The interopercle is a broad triangle fitting ventral to and between the preopercle and subopercle.

HYOID ARCH: (Fig. 18B). A small interhyal connects the hyomandibular with the epihyal. The latter is twice the size of the interhyal, and from it arise two strong branchiostegals, extending in a flat curve back close along the lower profiles of the interopercle and subopercle.

The ceratohyal is a stout bone, three times as long as the epihyal, ossified only in its median portion, although its entire profile is visible, especially anteriorly where it articulates with the basihyals. These almost merge in the midline, the opposing surfaces mutually corrugated as if they articulated.

In the mid-line of the throat lies the large urohyal, its bifurcated anterior tip close to the ceratohyals, and its broad, rounded, posterior end extending half-way the whole length of the branchiostegals.

PECTORAL GIRDLE: The supra-cleithrum extends only very slightly beyond the inferior end of the post-temporal. With it articulates the broad, rounded end of the cleithrum, which thence extends, now enlarging, now contracting in profile, down, and slightly forward, interior to the posterior third of the opercle and ending beneath the subopercle.

VERTEBRAL COLUMN: The clearing was stopped before the body tissues became transparent, so I can see little of the vertebrae. Anteriorly they are fairly well ossified, but posteriorly, at least from the rear end of the dorsal fin, they are nearly transparent, and here considerably enlarged in diameter, up to the very last. The urostyle is very strongly ossified, and extends as a straight rod,

from the end of the column, obliquely up to the surface of the upper profile of the very deep peduncle, pushing its head between the bases of the most posterior, upper, caudal spine.

FINS: The rays of all the fins, both vertical and paired, are very strongly ossified, the pterygials and baseosts less so.

The pectoral pad shows four well developed pterygials, with broadened distal ends. These four expanded heads are more or less closely connected with the second, third and fourth; fifth, sixth and seventh; eighth, ninth and tenth; and eleventh, twelfth, thirteenth and fourteenth finrays respectively. There is a faint, but distinctly ossified, fifth pterygial element near the upper part of the fin.

The fifteen dorsal rays show twelve baseosts, the anterior and posterior rays lacking them. The second and third show a single, high, thickened, anteriorly directed bone. The first ray is very short and the two lateral bases are not joined, standing erect as two short, curved, erect spines.

Of the eleven anal rays, only eight have ossified baseosts, the two anterior and the posterior ray lacking bony supports.

The typical, segmented caudal rays are 19 in number; 10 in the upper half and 9 below, with the two central rays well separated. Above and below the peduncle are 13 unsegmented caudal "spines." On the upper profile, the last of the spines is clamped over the end of the urostyle, while the succeeding three pairs are in intimate contact with three, long, flat, separate, neural spines.

DISCUSSION

A direct comparison between the characteristics of *D. binocularis* and those of all the other known specimens of *Dolichopteryx* may be made from the table on p. 58. Differing from all of the others in its great slenderness, *D. binocularis* approaches most closely the 58 mm specimen of Roule and Angel (1930 p. 73, pl. IV, figs. 94 and 95), described as a *Dolichopterygiella*. Even this latter specimen, however is comparatively deep (depth 14 in total length, not 20, as in *D. binocularis*) and has the pectoral rays perfectly graduated in length instead of divided into two unequal groups.

STUDY MATERIAL

The type is in the collections of the Department of Tropical Research of the New York Zoological Society. It has been cleared and stained as KOH No. 960.

The following material has been filed: Colored plate B827; outline drawings B828, B828a, B889, B890, B891, B892; photographs 6160-L and 6307-L.

The figure of *D. binocularis* has been redrawn, as that in Zoologica, vol. XIII, no. 4, p. 48 was found to be inaccurate in several respects.

***Dolichopteryx longipes* (Vaillant 1888)**

**SPECIMENS TAKEN BY THE BERMUDA
OCEANOGRAPHIC EXPEDITIONS**

4 specimens; June to September; 1929 and 1930; 600 to 800 fathoms; from a cylinder of water 8 miles in diameter (5 to 13) miles south of Nonsuch Island, Bermuda), the center of which is at 32° 12' N. Lat.; 64° 36' W. Long.; Standard lengths from 23 to 85 mm.

PREVIOUSLY RECORDED SPECIMENS

4 specimens; 191 to 2187 fathoms; Atlantic and Indian Oceans; Standard lengths from 35 to 120 mm. (Fig. 19).

SPECIFIC CHARACTERS

Whether or not all of the specimens synonymized by Norman (1930, p. 271) with *Dolichopteryx longipes* and those described by Roule and Angel (1930 p. 69 ff) under the heading *Dolichopterygiella* prove eventually to be of the same species and identical with the present series, all are distinguished at once from *D. binocularis* Beebe 1932 by the relative thickness of the body (depth in standard length 7.7 to 13 instead of 17). The following measurements and counts are applicable to all the known specimens of the genus except *D. binocularis*: *Color*: White, sometimes with black chromatophores on head and trunk and several pairs of ventral subdermal spots. *Proportions*: Depth in length 7.4 to 13; head in length 2.4 to 5; eye in head 6 to 10.6; snout in head 2 to 2.6; distance from pelvic to caudal base in distance from snout to pelvic 1.75 to 3.5. *Finray Counts*: Pectoral 13 to 14; pelvic 6 to 12; dorsal 5 to 15; anal 8 to 12. *Teeth*: In all specimens where teeth have been noted, they are minute, arranged in bands in upper jaw and in a single row in the lower. (See also the table on p. 58 and discussion on p. 56).

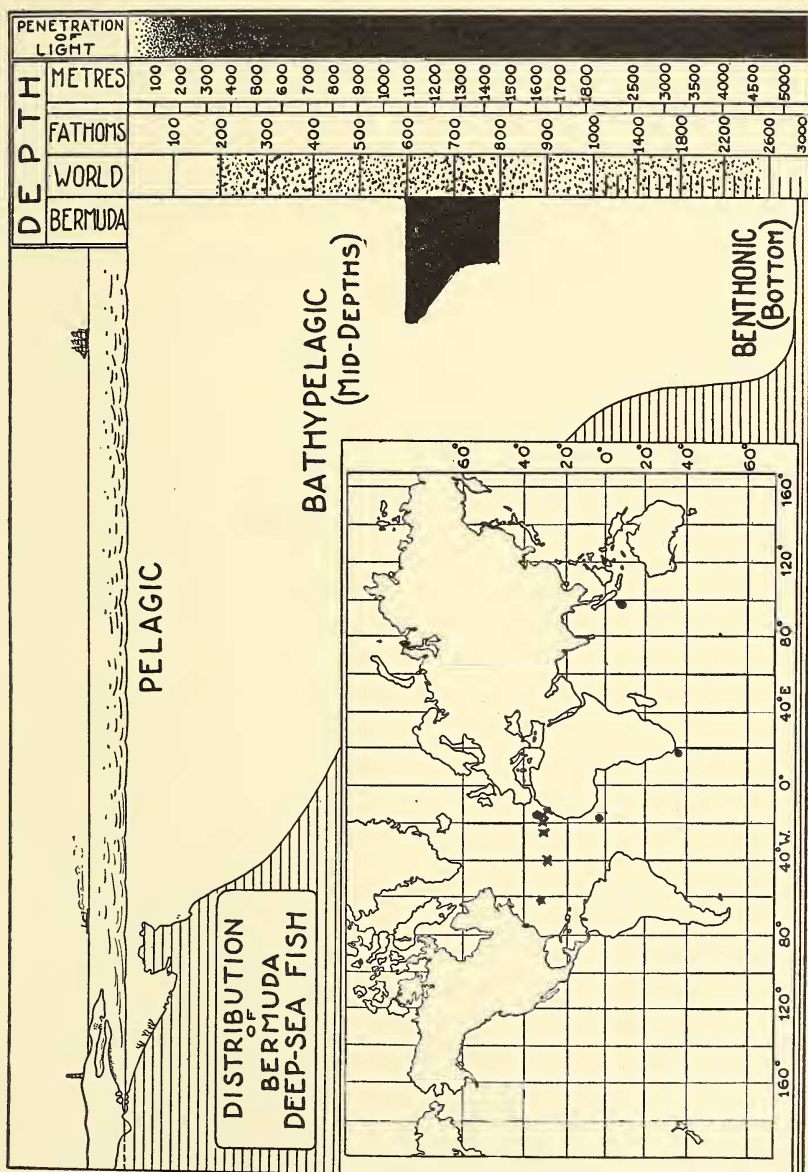


Fig. 19. *Dolichopteryx* Brauer. The approximate geographical and vertical distribution of all recorded specimens of the genus. The dots indicate where *D. longipes* has been taken, the crosses, *Dolichopterygella* of Roule and Angel. Bermuda, where both *D. longipes* and the type of *D. binocularis* were taken, is marked by a star. The relative number of specimens taken at different depths by the Bermuda Oceanographic Expeditions is shown diagrammatically at the right, for comparison with the previously known vertical range of the genus.

DEVELOPMENT

EGG: The 100 well developed eggs found in each ovary of an 85 mm female (No. 13,062a) are round, white (after three years in preservative) and .2 mm in diameter. These are located in the middle and posterior parts of the ovaries only. In the anterior portions and between the white eggs are at least six times as many smaller, yellowish, translucent, undeveloped eggs, which gives an estimated total of 1400 eggs in both ovaries.

LARVA AND POST-LARVA: No example of either of these stages has been taken by the Bermuda Oceanographic Expeditions.

ADOLESCENT: (Fig. 20A). Due to lack of material for comparison, it is impossible to be sure whether the single 23 mm specimen in the present collection is in the post-larval or adolescent stage. However, taking as criteria the differentiation of the fin rays and the development of the teeth, as well as the high degree of ossification of a cleared and dyed example from the same net which is but 12 mm longer, the 23 mm specimen is probably adolescent.

Trawling Data: Department of Tropical Research No. 8827a; Bermuda Oceanographic Expeditions of the New York Zoological Society; Net 22; April 15, 1929; 9 miles south of Nonsuch Island, Bermuda; 600 fathoms; Standard length 23 mm.

Measurements and Counts: Total length 26.1 mm; standard length 23 mm; depth 2.4 (in length 9.6); head 7.4 (in length 3.1); eye .7 (in head 10.6); snout 3.3 (in head 2.2); pectoral rays 13; pectoral length 2.3 (broken off); pelvic rays 9?; pelvic length 2.3; dorsal rays 10?; anal rays 9?; caudal rays IX+10+10+IX.

External Characters: In general color the fish is white, with faint black chromatophores around the mouth, in a line along the maxillary, on the crown of the head, at the base of the pelvic and at the extreme base of the caudal fin. The top of the head and snout is almost transparent. Through the tissues of the ventral surface five pairs of good sized, dendritic chromatophores are visible lying along the intestine. The skin of the trunk is entirely missing, so that the superficial markings of this region are unknown.

The body is almost cylindrical and moderately elongate, tapering but slightly from the shoulders to the base of the caudal fin. The bases of both paired and vertical fins are conspicuously elevated.

The crown of the fairly large head is little elevated above the

level of the nape; from here the forehead and elongate snout slope gradually to the tiny, terminal mouth. The lower jaw slants downward and back to its angle at a point but two-fifths of the distance between the tip of the snout and the vertical from the anterior margin of the eye. Posterior to this the ventral profile of the head is unbroken and perfectly horizontal. The eye is directed straight upwards with the entire external portion of the lens projecting above the level of the interorbital profile. Minute teeth are present in

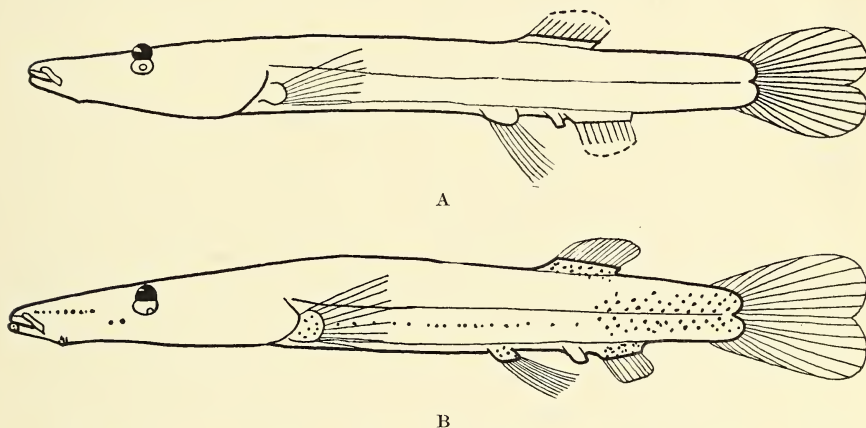


Fig. 20. *Dolichopteryx longipes* (Vaillant). A, adolescent, 23 mm.; B, young adult male, 35.5 mm.

the premaxillary, maxillary and mandible, those in the upper jaw being at least biserial. The gill openings are moderate, with their upper boundary at a point half the distance between the ventral and dorsal profiles.

The pectoral rays arise from well developed pads and show no division into groups; they reach but one-fourth of the distance between their base and that of the pelvics, but have evidently been broken off. The pelvics likewise are undivided, and extend to beyond the anal origin. They are 2.6 times as far from the origin of the snout as from the caudal base, and the base of the first ray is 1.1 mm in front of the vertical from the dorsal origin. The anal commences under the middle of the dorsal. Between the most posterior of the feebly developed, dorsal, caudal raylets and the first of the stout, terminal, true caudal rays is the projecting tip of the urostyle. The rays of all of the fins are double.

The large photophore found on the iris of older specimens is represented only by a pale-colored bulge near the orbital margin.

ADULT: The three remaining specimens in the collection consist of one young male (35.5 mm), one young female (40 mm) and one mature female (85 mm). Descriptions of all three follow.

YOUNG MALE: (Fig. 20B). *Trawling Data*: Department of Tropical Research No. 8827; Bermuda Oceanographic Expeditions of the New York Zoological Society; Net 22; April 15, 1929; 9 miles south of Nonsuch Island, Bermuda; 600 fathoms; Standard length 35.5 mm.

Measurements and Counts: Total length 40.5 mm; standard length 35.5 mm; depth 4.6 (in length 7.7); head 14 (in length 2.5); eye 1.4 (in head 10); snout 6.2 (in head 2.3); pectoral rays 13; pectoral length 4.3; pelvic rays 11; pelvic length 6.4; dorsal rays $11\frac{1}{2}$; anal rays 10; caudal rays XI+10+10+IX.

External Characters: The entire fish is white marked with chromatophores distributed as follows: A close-set line of black ones on each side of the mandible and isthmus; a broad band of brown pigment, visible through the tissues of the snout, on the roof of the mouth extending from the inner series of teeth to almost three-quarters of the distance between the tip of the snout and the anterior margin of the eye; two single, black spots on the cheek, below and in front of the eye; a series of black chromatophores above the lateral line, and a similar one below it, from pectoral to caudal base. Due probably to the damaged condition of the skin, these are nearly obliterated in the anterior part of the fish, but posterior to the pelvic fin each series is seen to be composed of oblique rows of chromatophores, one row to each myomere and two or three chromatophores in each row. Each pigment spot consists of a small, dark, central nucleus in the center of a lightly pigmented disc. The border of the latter is usually darker, giving a definitely bounded, ringed appearance. At the base of the caudal fin the chromatophores are smaller, and a few of them are dendritic. Here the linear formation is lost, there being simply two clusters of the dots, one above and one below the lateral line. The bases of all the fins are similarly pigmented. At least five pairs of subdermal, abdominal spots are faintly visible between the pectoral base and the anal origin. In the same area the wall of the coelom shows brown through the abdominal tissues, from a fusion of densely scattered, dendritic chromatophores. Iris black. Iris photophore bronze.

This specimen is relatively deeper, and has a larger head than any of the other specimens. Otherwise it is of typical *Dolichopteryx* contour, being almost cylindrical, tapering but slightly and having the fin bases elevated. The perfectly telescopic eyes do not extend to the height of the bony interorbital ridge. The maxillary reaches to a point about a third of the distance between the tip of the snout and the vertical from the anterior border of the eye.

In the premaxillary are about two rows of minute teeth. In the anterior part of the maxillary they are also biserial, but become single posteriorly; in size all are about equal to those of the premaxillary. There are about thirty teeth in each half of the mandible in a single row. These are very small and close-set in the anterior four-fifths of the jaw, being but one-third the size of those in the maxillary; the most posterior six or seven, however, become rapidly larger, approaching in size those of the upper jaw.

There is no trace of scales anywhere on the body.

The longest pectoral rays, which are probably broken, extend slightly more than half-way between their base and that of the pelvics. The rays of the latter reach to mid-anal. The upper four or five pectoral rays are slightly separated from the lower ones, but the pelvics are quite undivided. Inserted only 2.1 times as distant from the tip of the snout as from the caudal base, they are located slightly farther forward than in any of the other Bermuda specimens; between the pelvic base and the vertical from the dorsal origin is 2.4 mm. The anal originates under the last dorsal ray. The tip of the urostyle is invisible externally.

There is a moderate sized, semicircular photophore on the outside of the eyeball, directed straight inward. No trace is found of the ventral band of luminous tissue found in *D. binocularis*.

Osteology: In the head the jaws, teeth, frontal, parasphenoid, quadrate, metethmoid and opercles are all strongly ossified, and in arrangement and form are closely similar to those of *D. binocularis*. In the vertebral column are 43 vertebrae plus urostyle. The anterior vertebrae are rather small (.75 mm in diameter at neck), becoming considerably larger at mid-body, reaching their maximum size just in front of the dorsal (1.1 mm in diameter) and continuing very deep clear to the caudal. The entire column is well ossified, with the exception of the 40th and 41st vertebrae. In these the lower halves are almost unossified, the upper halves entirely so. The

urostyle, which terminates between the bases of the most posterior of the dorsal caudal raylets and the first true caudal rays, is also strongly ossified, though the hypurals and epurals show no trace. The cleithrum and supra-cleithrum are both strongly ossified; the pelvic girdle, very slightly, except that the long, pelvic bone shows a considerable amount of ossification throughout the distal half. All of the fin rays are well ossified, their baseosts very slightly.

Digestive System: (Fig. 21). All of the digestive organs are white. The stomach (7.3 mm) is an elongate, blind sac, not much broader than the oesophagus. The intestine, less than twice as

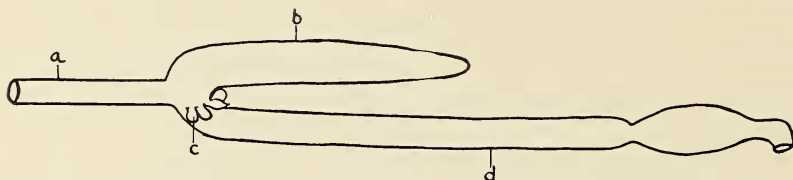


Fig. 21. *Dolichopteryx longipes* (Vaillant). Alimentary canal. a, oesophagus; b, stomach; c, caeca; d, intestine.

long (14 mm) opens from it at its anterior end, and extends straight backward to the level of the pelvic fins. Here there is an abrupt constriction followed by a short swelling, which narrows again just before reaching the anal papilla. The liver lies far forward against the oesophagus, just behind the .6 mm heart (auricle and ventricle) and measures 1.7 mm in length. The pyloric region is damaged, but there seem to have been several caeca.

Reproductive System: But one testicle is present, due to damage to the specimen. This lies on the left side, outside of the liver, beginning at the level of its posterior half. It is short and broad, measuring 1.9 mm in length. There is a minute sperm duct.

YOUNG FEMALE: Trawling Data: Department of Tropical Research No. 18,400; Bermuda Oceanographic Expeditions of the New York Zoological Society; Net 862; Sept. 8, 1930; 9 miles south-east of Nonsuch Island, Bermuda; 800 fathoms; Standard length 40 mm.

Measurements and Counts: Total length 46.2 mm; standard length 40 mm; depth 4.3 (in length 9.3); head 11.4 (in length 3.5); eye 1.7 (in head 6.7); height of eye 2.1; snout 4.7 (in head 2.4); pectoral rays 13; pectoral length 5; pelvic rays 9; pelvic length 10.7; dorsal rays 11; anal rays 9; caudal rays XIV+10+10+XI.

External Characters: The following color notes were made from the fresh specimen: General color translucent white; much of the upper, anterior half of the head transparent covered with very thin tissue, over which extend 5 or 6 oblique, nerve threads; the white brain, well back of the eye, is quite isolated in this transparent area; base of eye glittering steel blue; a dense sprinkling of round, black, chromatophores about the jaws. Trunk chromatophores: An enormous, dark, dendritic chromatophore covers the outer part of the pad of the pectoral base; eight large, irregular chromatophores, as large as the pectoral one, are arranged along the side of the body; from the base of the pectoral back along the lower part of the side to the caudal base runs a line of very fine, glittering, greenish-black shreds of pigment, first as a continuous line, then, posteriorly, as a series of irregular, oblique lines, of 5 to 9 dots each; at the base of the caudal a rather thick scattering of round, black pigment dots. The stomach and intestine show bright pink from ingested food.

This specimen differs in general appearance from that of the 35.5 mm male in the somewhat slimmer body, shorter head and larger eye, which interrupts the cephalic profile. But in the arrangement of the teeth and the relative positions of the pelvic, dorsal and anal fin the two specimens are very similar. The rays of the paired fins are not divided into two groups. The pectoral is broken, but the longest pelvic rays almost reach the base of the caudal fin.

Digestive System: The digestive system corresponds to that of the young male in every particular. There are four short caeca, .8 mm in length.

Reproductive System: The ovaries are duplicates in miniature of those found in the mature female subsequently described. They are filled with exceedingly minute, unripe eggs.

MATURE FEMALE: *Trawling Data:* Department of Tropical Research No. 13,062a; Bermuda Oceanographic Expeditions of the New York Zoological Society; Net 418; Sept. 4, 1929; 10 miles south of Nonsuch Island, Bermuda; 700 fathoms; Standard length 85 mm.

Measurements and Counts: Total length 98.5 mm; standard length 85 mm; depth 10 (in length 8.5); head 36 (in length 2.4); eye 4.7 (in head 7.7); snout 17 (in head 2.1); pectoral rays 14, broken off short; pelvic rays 9; pelvic length 19; dorsal rays 11; anal rays 10; caudal rays IX + 10 + 10 + XI.

External Characters: The pigmentation of the head is close to that of *D. binocularis* (Fig. 16); that of the trunk resembles the markings of the young male (Fig. 20B), except that in the present specimen the chromatophores are much more pronounced, and that the rays of the paired fins are pigmented in the following fashion: The uppermost 7 pectoral rays are peppered throughout their length with small chromatophores. All of the pelvic rays are heavily pigmented across their bases; the fourth, fifth and sixth are pigmented throughout their length and are the longest; and the third and seventh rays are pigmented in their distal thirds as well as their bases.

In general proportions this specimen approaches the 35.5 mm male more closely than the 40 mm female. The eyes do not interrupt the dorsal profile. The teeth of the upper jaw are all inside its margin on the roof of the mouth and are in three or four rows. Those in the mandible are uniserial. The pelvic, dorsal and anal fins are inserted in the same relative positions as in the two smaller adults. The longest pelvic rays extend almost to the first caudal spines.

Digestive System: In every detail the digestive system of this large specimen is exactly similar to those of the smaller fish already described.

Reproductive System: The ovaries are slender, ribbon-like organs extending the length of the coelomic cavity. They are broadest anteriorly, measuring .9 mm, but posteriorly they dwindle to a mere thread. No oviduct is visible. The eggs have already been described (p. 72).

ECOLOGY

VERTICAL AND SEASONAL DISTRIBUTION: Due to the small number of specimens taken, no bathymetric and seasonal conclusions can of course be drawn. However, it may noted be that all four occurred in the mid-depth region—between 600 and 800 fathoms—which is so typical of all of the Bermuda Alepocephalids. In Fig. 19 is indicated this Bermuda vertical distribution in relation to the depths at which previously recorded specimens occurred. The present specimens were caught in April and September only.

SOCIABILITY: The two smallest specimens came up in the same net. In a species as rare as this, it is almost certain that this was not accidental but that the fish were actually swimming together.

ABUNDANCE: This is one of the rarest of deep-sea fish. Even within the narrow limits of its Bermuda vertical distribution (600 to 800 fathoms), it occurred in less than .8 per cent of the nets drawn between those depths.

FOOD: The stomachs of the two smaller fish were partially filled with finely digested, unrecognizable material; that of the 85 mm female was quite empty. In all of the specimens there were small quantities of food in the intestines.

STUDY MATERIAL

The following list gives the catalogue number, net, depth in fathoms, date, length and growth stage of the Bermuda specimens of *Dolichopteryx longipes*. All were caught in the cylinder of water off the Bermuda coast described on p. 5.

No. 8,827; Net 22; 600 F.; April 15, 1929; 35.5 mm; Adult.

No. 8,827a; Net 22; 600 F.; April 15, 1929; 23 mm; Adolescent.

No. 13,062a; Net 418; 700 F.; Sept. 4, 1929; 85 mm; Adult.

No. 18,400; Net 862; 800 F.; Sept. 8, 1930; 40 mm; Adult.

No. 8,827 (KOH No. 1150) was cleared and stained in order to study the skeleton.

The following material is filed: Colored plate B732; outline drawings B894, B895 and B897; photographs B5696 and B5821-L.

SYNONYMY AND REFERENCES

Aulostoma? longipes:

Vaillant 1888, p. 340, pl. XXVII, fig. 4. (1 specimen; 45 mm; 1163 m.; coast of Morocco; *type specimen*).

Goode and Bean 1895, p. 484, fig. 397. (Résumé of type description).

Dolichopteryx longipes:

Norman 1930, p. 271, fig. 3. (2 specimens; 120 and 100 mm; 350–400 (–0) m. and 2500–2700 m.; off Cape Town and Liberia respectively).

Dolichopteryx anascopa:

Brauer 1902, p. 127. (1 specimen; 34.8 mm; 2400 m.; Indian Ocean west of Cocos Island).

Brauer 1906, p. 24, fig. 4. (Supplementary description of *D. anascopa* with discussion of its possible synonymy with *A? longipes*).

Dolichopterygiella:

Roule and Angel 1930, p. 69. The majority of this series of 7 specimens is probably *D. longipes*; 8 to 76 mm; 0-4000 m.; eastern Atlantic, off North Africa.

Macromastax Beebe 1933

GENERIC CHARACTERS: Elongate, moderately compressed Alepocephalids, with naked, delicate skin, no sign of tubercles, and no nuchal dermal fold; lateral line distinct; the head large (less than 3 in length); the mouth very large, with the maxillary reaching far beyond the posterior margin of the orbit; the jaws nearly equal; snout short; the teeth uniserial, absent from the vomer, but present on the premaxillary, maxillary, mandible and palatine; the eye large; the gill membranes not joined beneath the isthmus; 9 branchiostegals; the paired fins are close to the ventral profile; the pectorals small and feeble; the pelvics well-developed, just within the posterior half of the fish; the dorsal is about twice as long as the anal, originating far in advance of it, at the vertical of the pelvics; caudal well-developed, forked.

COMPARISON WITH OTHER GENERA: This genus is immediately distinguishable from other scaleless Alepocephalids by means of the following characters:

From *Xenodermichthys* and *Rouleina* by the inequality of the vertical fins, the forward position of the dorsal, and the great size of the maxillary.

From *Leptoderma* by the shortness of the vertical fins, the fact that the dorsal is longer than the anal instead of vice versa, and by the great size of the maxillary.

From *Anomalopterus* and *Photostylus* (see p. 82) by the absence of an adipose fold in front of the dorsal fin.

In addition to its lack of scales, *Macromastax* differs most obviously from the remaining Alepocephalids as follows:

From *Bathytroctes* (including *Talismania*) in the great length of the maxillary, in the presence of 9 instead of 7 branchiostegals, and in the absence of vomerine teeth.

From *Bajacalifornia* in the lack of a pointed, symphysial knob, and in the large size of the maxillary.

From *Narctes* in having uniserial instead of polyserial teeth, and more than 7 branchiostegals.

From *Alepocephalus* (including *Conocara*), *Asquamiceps*, *Ericara*, *Leptochilichthys* and *Xenognathus* in the presence of maxillary teeth.

From *Platytroctes* in the presence of pelvic fins.

From *Aulostomatomorpha* and *Dolichopteryx* in the shortness of the snout and great size of the jaws.

***Macromastax gymnos* Beebe 1933**

(Fig. 22)

TYPE: Department of Tropical Research No. 10,829; Bermuda Oceanographic Expeditions of the New York Zoological Society; Net 210; June 22, 1929; 8 miles south of Nonsuch Island, Bermuda; 1000 fathoms; Standard length 35 mm.

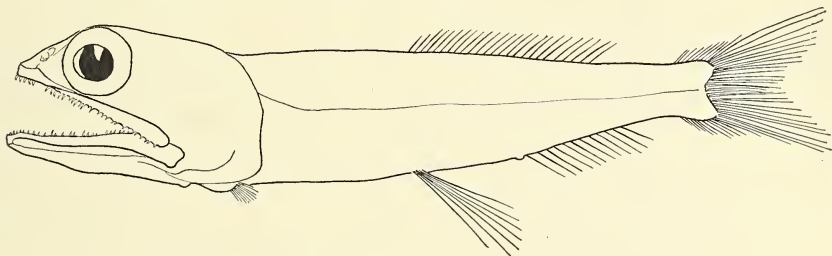


Fig. 22. *Macromastax gymnos* Beebe. $\times 2.6$.

MEASUREMENTS AND COUNTS: (These measurements were made from the fresh specimen). Total length 42.2 mm; standard length 35 mm; depth 6.5 (in length 5.4); head 12.8 (in length 2.7); eye 3.5 (in head 3.7); snout 2.1 (in head 6.1); maxillary 8.5 (in head 1.5); pectoral ca. 10; pectoral length 2.2; pelvic 7; pelvic length 6.3 dorsal 25; anal 12; 9 branchiostegals.

GENERAL DESCRIPTION: Moderately elongate and compressed, the head very large, deeper than the body and contained 2.7 in the length. In the fresh specimen, body pale grayish, peduncle and caudal fin lighter, the latter with many irregular, white marks; head, opercles and body cavity jet black; iris blue-black. Top of head straight, dipping abruptly at front of eye to short, blunt snout; dorsal and ventral profiles almost horizontal, the slope being very slight to the short, thick peduncle; eye very large, 3.7 in head, almost filling the space between the top of the head and the maxillary line; pupil elliptical; nostrils large, oval, half-way between eye and snout,

with a conspicuous, raised rim, showing white, narial tissue, and an elevated, anterior flap; the mouth is exceedingly long, the maxillary 1.5 in head, and straight.

There are 5 short, recurved teeth on each premaxillary ramus, and 24 along the maxillary, separated and rather irregular; on the posterior third these tend to be arranged in pairs; on the mandible are 44 teeth, equally small and curved; some of these are not in perfect alignment, but there is no evidence of biseriality; each palatine has 6 teeth, but there are none on the vomer.

The skin is thin and scaleless, the lateral line well marked, horizontal except near the opercle where it rises gently. The gill opening is large; the gill membranes quite free from the isthmus; there are 9 branchiostegals.

The dorsal fin is low and is twice as long as the equally low anal; the former begins far in advance of the anal, over the origin of the pelvics; the pectorals are close to the ventral profile and beneath the opercular membranes, very short and quite functionless, although the 10 minute rays are fully webbed; the pelvics are well-developed, elongate, close behind the center of the body, and also close to the ventral line; the last rays of each are inserted so close together that they almost touch.

Type in the collections of the Department of Tropical Research of the New York Zoological Society.

REFERENCE

Macromastax gymnos

Beebe 1933, p. 162, fig. 40. (Type description).

Photostylus Beebe 1933

This genus differs from all the *Alepocephalidae* except *Anomalopterus* in having a prominent pre-dorsal fold or adipose fin along the back. It differs from that and other closely related genera (such as *Rouleina* and *Xenodermichthys*) in its steeply ascending, concave snout, small head and relatively high and well developed pectoral fins. The skin is without scales; the jaws are equal, with a prominent symphysial knob; the mouth moderately large; teeth present on the premaxillary, maxillary, mandible and palatine; 6 branchiostegals; pectorals large and placed high; pelvics small; vertical fins almost equal, far back.

Photostylus pycnopterus Beebe 1933

(Fig. 23)

TYPE: Department of Tropical Research, No. 10,217; Bermuda Oceanographic Expeditions of the New York Zoological Society; Net 137; May 30, 1929; 9 miles south-east of Nonsuch Island, Bermuda; 800 fathoms; Standard length 64 mm.

MEASUREMENTS AND COUNTS: (From fresh specimen, now shrunk as to length and eye). Total length 71 mm; standard length 64 mm; depth 9.2 (in length 6.9); head 11 (in length 5.9); eye 2.5 (in head 4.4); interorbital 2.5 (in head 4.4); snout 4 (in head 2.7); maxillary 5.8 (in head 1.9); branchiostegals 6; pectoral rays

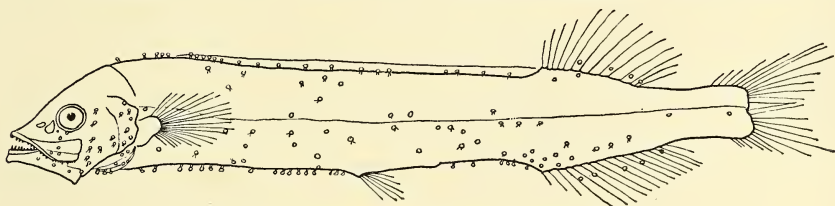


Fig. 23. *Photostylus pycnopterus* Beebe. $\times 1.5$.

18; longest pectoral ray 4.3; pelvic rays 6; pelvic length 4; dorsal $13\frac{1}{2}$; anal $17\frac{1}{2}$; caudal rays ca. 35; caudal tip slightly broken.

GENERAL DESCRIPTION: Considerably elongate and compressed; body profiles almost horizontal, sloping very slightly backward to the tail; the nape is somewhat elevated, and the head depressed, the top of the head curving evenly down to the eye, from whence to the tip of the snout the profile is concave; the ventral profile of the mandible extends obliquely downward, with a prominent posterior angle, well below the profile of the head; the vertical fins arise from elevated fleshy bases, considerably increasing the depth of the posterior body profile.

The head is small and considerably depressed when compared with other *Alepocephalids*; the snout is blunt; eye small, placed centrally in the head, pupil small; nostrils very large, roughly triangular, separated by a narrow septum, much closer to eye than to tip of snout; mouth moderately large, jaws equal in front; the symphysis of the mandible is prolonged downward (not forward as in *Bajacalifornia*) into a prominent knob; the maxillary is flat and greatly widened posteriorly, extending to the vertical of the posterior border of the eye.

Small teeth in uniserial rows are present on the premaxillary (27), maxillary (17), mandible (24), and palatine (2); the vomer is toothless; the teeth are close-set but besides the symphyseal gaps, there are other occasional, narrow, asymmetrical gaps and a few replacement teeth.

The skin is smooth, not noticeably thin, and scaleless even along the lateral line; the gill membranes are free from the isthmus. The head and body are covered with an irregular scattering of photophores, elevated on stalks: These consist of a terminal pigmented body, with a white or iridescent summit, the whole elevated on a thick, colorless stalk. These are most abundant on the sides of the head, along the jaws, on opercles and branchiostegals. On the body they are irregular and asymmetrically distributed, no portion, even the fin-rays, being quite free from them.

From the inter-mandibular membrane arise four pairs of singular looking organs, leaf-like but rather thick and dead white. Together with several small, adjacent patches, these seem to form an illuminating organ, comparable with nothing with which I am familiar in any other Alepocephalid.

The vertical fins are short, rather high, and placed far back on the body; the anal is slightly the longer, originating a little in advance of the dorsal; the caudal is well-developed, slightly forked; there are a few photophores scattered over the bases of all vertical fins; the pectorals are many-rayed, only slightly below the lateral line, and well above the ventral profile; pelvics shorter, very low, and about the middle of the body. On the nape, just back of the vertical of the fleshy base of the pectorals, there rises a thick, fleshy, median fold or adipose fin. This increases slightly in height and extends back to the dorsal, where it merges with the raised, fleshy base of that fin.

Looked at as a whole, this fish bears an amazing superficial resemblance to a larval Melanostomid—in particular in the low-swung head, the prominent mandibular angle and the fleshy bases of both paired and vertical fins.

Type in the collections of the Department of Tropical Research of the New York Zoological Society.

REFERENCE

Photostylus pycnopterus

Beebe 1933, p. 163, fig. 41. (Type description).

Genus *Xenodermichthys* Günther 1878

GENERIC CHARACTERS: Form moderately elongate, much compressed; body naked or with minute, rudimentary scales; tubercular luminous organs present at least on trunk; head moderately large; minute teeth at least on premaxillaries and mandible; 6 or 7 branchiostegals; paired fins small; dorsal and anal equal, fairly long (27 to 33 rays each) and about opposite.

NUMBER OF SPECIES: The genus *Xenodermichthys*, as now distinguished from *Rouleina*, includes three species, one of which was taken by the Bermuda Oceanographic Expeditions. All three are closely related, and the two Atlantic species are probably synonymous.

GEOGRAPHICAL DISTRIBUTION: *X. copei* (Gill 1884), previously known only from the type specimen, is from the western Atlantic; *X. socialis* Vaillant 1888 has been taken at many stations in the eastern and south-eastern Atlantic; *X. nodulosus* Günther 1878, also known only from the type, was taken by the *Challenger* off Japan. (See fig. 24).

VERTICAL DISTRIBUTION: *Xenodermichthys* has been taken at depths ranging all the way from 82 to 2949 fathoms (150 to 5393 meters); the Bermuda examples were caught at 600 and 700 fathoms (1097 and 1280 meters).

ABUNDANCE:

World: As has already been said, two of the three species in the genus have previously been known only from the type specimens. *X. socialis* has been taken about 20 times.

Bermuda: This fish is very rare in the Bermuda hauls.

SOCIABILITY: Although all three of the Bermuda specimens were taken singly, 133 of the young fish recorded by Vaillant (1888 p. 165) came up in the same net, while 3 of the Monaco Expeditions examples were taken at the same time (Roule and Angel, 1930, p. 12). Hence schooling does indubitably occur within the genus.

FOOD: A young Bermuda specimen had fed upon small crustaceans.

ENEMIES: *Xenodermichthys* has not yet been found in the stomach of any animal, nor have parasites been observed.

VIABILITY: There is no record of a living *Xenodermichthys* having been brought to the surface.

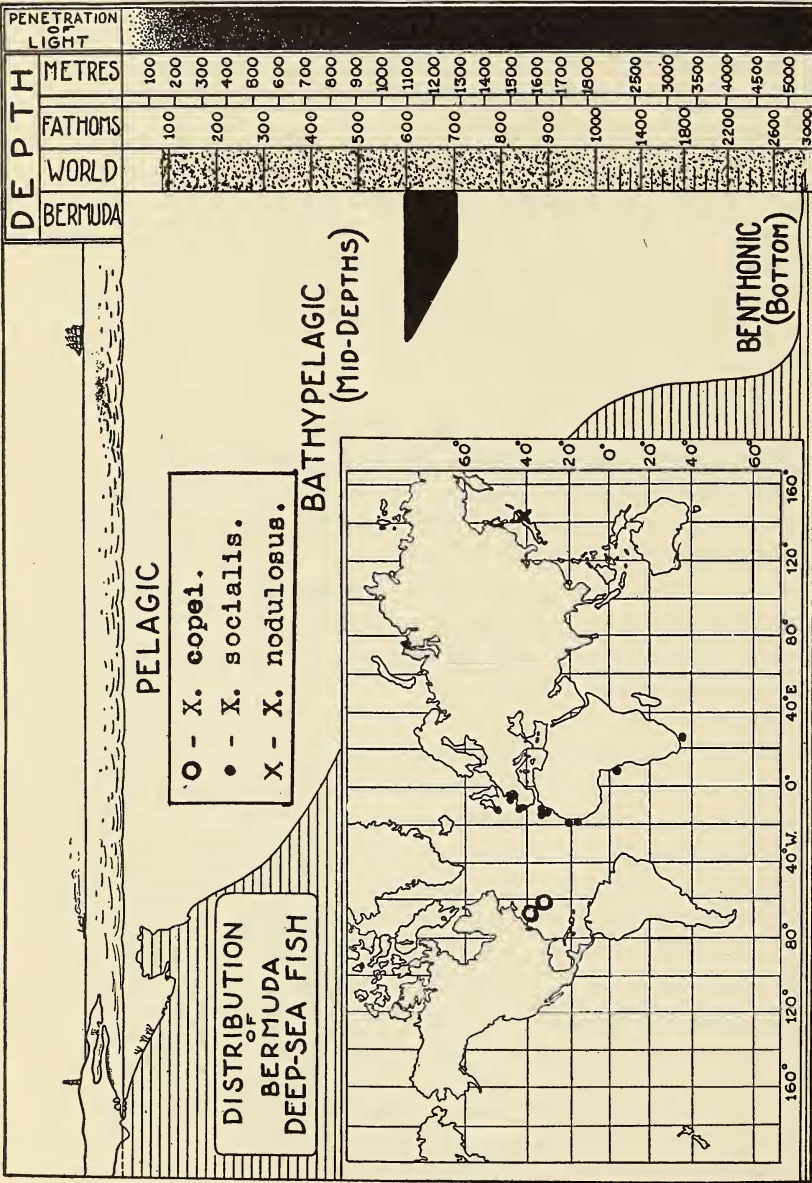


Fig. 24. *Xenodermichthys* Günther. The approximate geographical and vertical distribution of all recorded specimens of the genus. The relative number of specimens taken by the Bermuda Oceanographic Expeditions at 600 and 700 fathoms (the limits of its Bermuda vertical range) is shown diagrammatically at the right, for comparison with the previously known vertical range of the genus.

SIZE: The largest specimen of the genus on record is Günther's *X. nodulosus*, which measured about 200 mm in length. The smallest is the 20 mm specimen of *X. socialis*, recorded by Holt and Byrne (1908, V, p. 48), from off the south-west coast of Ireland.

The three examples of the present collection are all adolescent, measuring between 27 and 34 mm.

***Xenodermichthys copei* (Gill 1884)**

**SPECIMENS TAKEN BY THE BERMUDA
OCEANOGRAPHIC EXPEDITIONS**

3 specimens; September only; 1929 and 1930; 600 and 700 fathoms; from a cylinder of water 8 miles in diameter (5 to 13 miles south of Nonsuch Island, Bermuda), the center of which is at 32° 12' N. Lat., 64° 36' W. Long.; Standard lengths from 27 to 34 mm.

PREVIOUSLY RECORDED SPECIMEN

Type specimen only; 2949 fathoms; Western Atlantic; Standard length 88 mm (Fig. 24).

ADULT SPECIFIC CHARACTERS

As all of the Bermuda specimens are immature, the characteristics of the type alone are given in this place. *Color*: uniform blackish. *Proportions*: Depth in length, 5.5; head in length 3.7; eye in head 2; snout in head 5; maxillary extends to vertical from middle of orbit. *Finray Counts*: Not on record; from figure of the type, dorsal and anal, each, about 28. *Teeth*: Minute, on premaxillary and mandible. *Tubercles*: None visible on head, but numerous on the body (about 101 are shown in the figure of the type). The upper portion of the eye does not interrupt the dorsal profile of the head.

DEVELOPMENT

The three Bermuda specimens are all typical adolescents, characterized by a close resemblance to the adult except in the slenderness of the body and the large head, with somewhat small eye, and in the partially developed skeletal and reproductive systems. A description of one of the smaller specimens (Fig. 25), in which the tubercles were especially well preserved, follows:

Trawling Data: Department of Tropical Research No. 17,509;

Bermuda Oceanographic Expeditions of the New York Zoological Society; Net 822; Sept. 1, 1930; 8 miles south of Nonsuch Island, Bermuda; 600 fathoms; Standard length 27 mm.

Measurements and Counts: Total length 32 mm; standard length 27 mm; depth 5.4 (in length 5); head 8 (in length 3.4); eye 3 (in head 2.7); snout 1.6 (in head 5); maxillary 3.5 (in head 2.3); paired fins too damaged for counting; dorsal rays 27; anal rays 27; 6 or 7 branchiostegals.

External Characters: General color dark brown, darkest on lower part of head, opercles and abdomen, lightest on crown, shoulders and base of caudal. In a fresh specimen of equal size the photophores were dull blue much obscured by pigment.

The considerably compressed, moderately elongate body tapers regularly from shoulders to caudal base, being about two and one-half times deeper at the shoulder than at the narrowest part of the caudal peduncle. None of the fin bases are elevated and all of the rays are short. The head is of moderate size, the forehead sloping very gradually to the short, slightly convex snout. The large, elliptical eye does not interrupt the cephalic profile, and is surrounded by a thick, fleshy fold. The single pair of nostrils is located high on the snout, close to the eye. The mouth is rather small, the broad maxillary extending only to the vertical from about the middle of the eye. Teeth are present in the premaxillary (about 20) and mandible (at least 35 in each half); all are minute, nearly equal, although those in the premaxillary are slightly broader and wider set. The paired fins are both very short, the pelvics reaching to about half way between their origin and that of the anal. The latter is opposite the dorsal and equal to it. The caudal is forked.

There is no trace of scales even in the lateral line. The longitudinal wrinkles set with tiny papillae (remarked in *X. socialis* by Collett, Holt and Byrne, and Roule) are present here also, but are exceedingly minute, being barely visible under low power magnification. They are in the best condition along the middle of the side, just below the lateral line. The latter is complete from opercle to caudal base; it begins just above the dorsal end of the gill opening, descending gradually to the middle of the side, which it reaches at the vertical from the pelvic fin base. From here it continues straight backwards to the caudal base.

The short tubercles surmounted by photophores (in preserva-

tive whitish, clouded by pigment) are distributed as follows over each side of the head and body: Head about 25, small on the crown, larger below the eye (in a border of 4), on mandible, opercles and branchiostegal membranes; body, above lateral line, about 20; body, below lateral line, about 98; total 138. The skin above the lateral line is badly damaged, many of the photophores having evidently been lost, and no evidence of arrangement remains. Below the lateral line, however, from the pectoral base to that of the caudal fin the photophores are arranged, quincunxially, in definite, oblique rows which slant downwards and back. The 98 photophores are distributed among these rows as follows: Between base of pectoral and base of pelvic, 6 rows averaging 6 tubercles each; between base

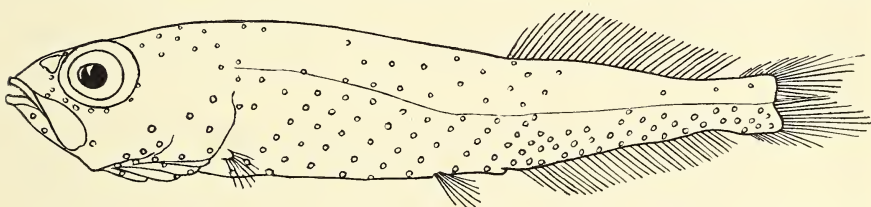


Fig. 25. *Xenodermichthys copei* (Gill). Adolescent specimen, 27 mm. in length.

of pelvic and origin of anal, 2 rows of 5 and 6 tubercles respectively; between origin of anal and base of caudal, traces of at least 15 rows averaging 3 to 4 tubercles each. On the caudal fin are found 4 single lights on the lower fin rays.

Osteology: In the cleared and stained specimen it is seen that the hyomandibular, preopercle, opercle, post-temporal and supra-cleithrum are fairly well ossified. The parasphenoid, gill-rakers, atlas and first six vertebrae show a lesser degree, while only faint traces are found on the margins of the mandible, quadrate and branchiostegals. The 7th through the 21st vertebrae also show a very light stain, confined in the last of these to the dorsal and ventral profiles alone of the bones. The finrays were all destroyed during the clearing process, but neither the pelvic girdles, the baseoste of the verticals, the hypurals, epurals nor urostyle show the least trace of ossification.

The bones of the right side of the skull are considerably less highly ossified than those of the left.

In so far as it can be determined from the incomplete state of

development of the bones, the structure of the skull is similar to that found in *Alepocephalus productus* (Gregory, 1933; fig. 51).

Digestive System: The relative positions, proportions and shape of the stomach, caeca and intestine are exactly as described and figured by Vaillant (1888, p. 164 and pl. XIII fig. 1g) for *X. socialis*. The black stomach of the present specimen measures 3 mm from the end of the oesophagus, or 1.6 mm from the anterior end of the intestine, to the tip of the blind sac. The six caeca are white. The intestine proceeds straight backwards for some distance, then describes three convolutions in the region of the pelvic fin, followed by an abrupt swelling, which contracts into an elongate, funnel-like neck just before reaching the anus. The last, narrow section is almost black, the remainder of the intestine brown. The position and form of liver and gall-bladder are unknown, as they were torn away through the damaged right side. Lining of coelom, dark brown.

Reproductive System: The gonads extend the full length of the dorsal wall of the coelom as very slender, white strands. They show no evidence of being at all close to breeding condition, and it is impossible to determine the sex of the specimen.

ECOLOGY

VERTICAL AND SEASONAL DISTRIBUTION: The three specimens all were taken at 600 and 700 fathoms in the month of September only.

FOOD: The single stomach examined was completely filled by a finely digested shrimp. In the anterior two-thirds of the intestine a large amount of unrecognizable crustacean remains was found.

DISCUSSION

The two Atlantic species of *Xenodermichthys*, *copei* (Gill 1884) from the western Atlantic and *socialis* Vaillant 1888 from the eastern Atlantic, are distinguished in the adult chiefly by the larger head (3.7 in length, not 4 to 4.3) and larger eye (2 in head, not 2.5 to 2.8) of *X. copei*. Due to the immaturity of the present specimens no attempt is made here to decide the question of the identity of the two species. The Bermuda specimens agree slightly better with the descriptions of the young of *X. socialis* by Holt and Byrne (1908, V, p. 48) than with that of the fairly large type speci-

men of *X. copei*. However, the characters involved, such as the small size of the eye, vary from the type only to a degree usually found in young *Alepocephalids* when compared with older ones, and in view of their geographical occurrence the Bermuda specimens are referred to *copei*.

STUDY MATERIAL

The following list gives the catalogue number, net number, depth in fathoms, date, length and growth stage of each specimen of *Xenodermichthys copei* taken by the Bermuda Oceanographic Expeditions. All were caught in the cylinder of water off the Bermuda coast previously described (p. 5).

No. 13,871; Net 511; 700 F.; Sept. 27, 1929; 34 mm; Adolescent.

No. 17,509; Net 822; 600 F.; Sept. 1, 1930; 27 mm; Adolescent.

No. 18,607; Net 890; 600 F.; Sept. 15, 1930; 27 mm; Adolescent.

Specimen No. 17,509 (KOH No. 1147) was cleared and dyed in order to study the skeleton.

In the files is outline drawing no. B509.

SYNONYMY AND REFERENCES

Aleposomus copei

Gill 1884, p. 433. (Brief preliminary note on the type specimen).

Goode and Bean 1895, p. 47, fig. 51. (Complete description of type specimen).

Jordan and Everman 1896, p. 459. (Résumé of the description by Goode and Bean).

Brauer 1906, p. 21. (Key to the species of *Aleposomus*).

Roule 1919, p. 10. (Discussion of possible synonymy of *A. copei* and *X. socialis*).

Xenodermichthys copei

Norman 1930, p. 270. (Mention of possible synonymy of *X. copei* and *X. socialis*).

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